PROJECT MANAGEMENT INFORMATION SYSTEM FOR OCEAN RESEARCH PROJECTS

RUPINDER SINGH RANGAR


CENTRE FOR NFLD. STUDIES
JUN 10 98
MEMORIAL UNIVERSITY
OF NEWFOUNDLAND

PROJECT MANAGEMENT INFORMATION SYSTEM

FOR

OCEAN RESEARCH PROJECTS

by

Rupinder Singh Rangar, B.E. (Civil)

A Project Report submitted in partial fulfilment

of the requirements for the degree of

Master of Engineering

Faculty of Engineering & Applied Science

Memorial University of Newfoundland

May 17, 1979

St. John's Newfoundland

ABSTRACT

Newfoundland Oceans Research and Development Corporation Limited (NORDCO) was established in 1975 as a crown corporation for the exploration of opportunities related to ocean services and technology. By exploring these opportunities, it is to enhance the capabilities of the Province to undertake research and to provide services for developing the technology required for ocean research in the North West Atlantic.

The company mandate requires it to operate on an aggressive commercial basis to substantially recover its operating costs. To achieve this objective, among other things, the company has introduced a project management system to control its research projects.

This project report addresses the problem of conceiving, designing and implementing a management information system to suit the specific needs of NORDCO. Computer program Project Management System IV (PMS-IV), a general purpose project management program, has been adapted for research projects. The elements of management information in ocean research environment have been identified, the responsibilities of staff towards project management have been analyzed and suitable information packages have been developed. Both computerized and manual reports are presented to the management on a monthly basis.

ACKNOWLEDGEMENTS

The author is very grateful to his supervisors:

Professor H.N. Ahuja, Faculty of Engineering and Applied Science, Memorial University of Newfoundland, for his support and encouragement in the application of Project Management System to ocean research projects.

Dr. R.T. Dempster, Dean of the Faculty of Engineering and Applied Science, Memorial University of Newfoundland, for his guidance and advice in completing this study.

Thanks are due to Dr. F.A. Aldrich, Dean of Graduate Studies, Memorial University of Newfoundland, for offering the Fellowship award and help during the graduate studies.

Sincere thanks are also due to Mr. J. Furst, P.Eng., President and General Manager, Newfoundland Oceans Research and Development Corporation (NORDCO) Limited, St. John's, Newfoundland, for his support to undertake this study.

Last, but not least, sincere thanks are due to Mr. G. Somerton, Newfoundland and Labrador Computing Services, for his valuable advice and assistance in running the computer program.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

LIST OF ABBREVIATIONS

CAT	Cost Analysis Table
CP	Cost Processor
IAT	Information Analysis Table
NORDCO	Newfoundland Oceans Research & Development Corporation Limited, St. John's, Newfoundland
NP	Network Processor
OAT	Organization Analysis Table
PMS IV	IBM Computer Package Project Management System IV
RAP	Resource Allocation Processor
RP	Report Processor
Rate-ID	Rate Identifier
RT	Rate Table
WBS	Work Breakdown Structure

LIST OF FIGURES

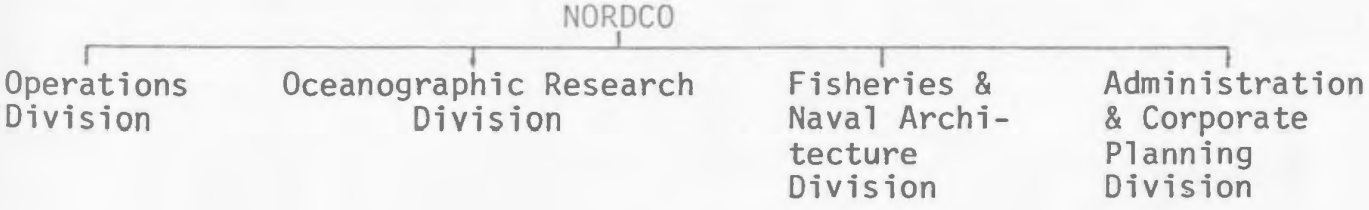
LIST OF TABLES

INTRODUCTION

Newfoundland Oceans Research and Development Corporation Limited (NORDCO) is a crown corporation established in 1975. Its aim is to specialize in research and technology related to Arctic and other cold water environment and to establish itself as an internationally recognized centre of northern oceans' resources exploitation and ice related expertise. Federal and Provincial government grants of upto $5 million have been made available to the company as seed money during the first five years of its establishment and growth. The growth rate of the company to date is indicated by the information provided below:

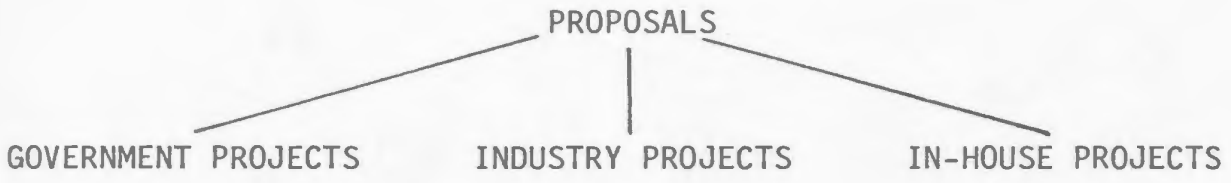
	1975-76	1976-77	1977-78
Permanent Staff	18	32	56
Annual Gross Revenue	$156,000	687,000	618,000
Annual Operating Costs	$272,000	605,000	1,075,000
Number of Projects & Proposals	5	65	120

During this period, the company has continuously revised its organizational structure to take advantage of the identified opportunities in North West Atlantic. The present set up of the company is:



Each of these Divisions is headed by a Director and is a cost centre within the company. The overall control of the company is exercised by the President and General Manager, who in turn, is responsible to the Board of Directors.

Research effort within the company is classed in three categories viz government projects, industry projects and in-house projects. In addition to this there is the continuous activity of writing proposals. Proposals are an essential prerequisite to any project as they define the methodology, time frame and approximate cost of undertaking the project.



While government and industry projects generate revenue to the company, in-house projects are undertaken in selected areas having a possible revenue potential in the future.

The utilized mandays of researchers on government and industry projects are the primary source of revenue to the company. At its present establishment level, it has over 8,000 researcher mandays available annually, which at an average chargeout rate of $200 per day have maximum revenue potential of over $1.5 million. The effective utilization of this resource is fundamental to the successful operation of the organization. But this is not simple as the problem is manifest with

many unknowns. The performance of the researcher is difficult to quantify and the time estimates of their employment on projects are based on the judgement and experience of individual researchers and need revisions with project progress. The availability of researchers to coincide with project progress is critical but this is not always possible due to their unexpected longer utilization on earlier projects on which they are already committed or due to their absence.

Project management challenge to NORDCO lies in the application of project management system to the control of research project and proposal activities which originate from different areas of research in the company and to integrate this research within the folds of a total management system. Although individually these research activities do not make any serious impact on the company resources, cumulatively their demands can be heavy requiring careful planning and coordination. The fast pace of these activities makes the task of maintaining any worthwhile past records difficult.

PROBLEM DEFINITION

Due to the nature of the market place, about 95% of the projects undertaken by the company so far (both contract work and in-house research) have been under $50,000. These projects generally have short durations of three to six months. At the height of research activity during the working season (May - October 1978), there were as many as 40 projects and proposals ongoing at any one time at different stages of progress. This type of research activity makes the task of project management extremely difficult.

In a situation where researchers work within their Divisions on more than one project/proposal at any one time and also on projects in other Divisions where their particular expertise is needed, the management of research by the Division Directors poses difficulties of control. Providing appropriate project information to researchers and management on a regular basis through simple procedures and design of information channels is equally difficult.

CHAPTER I

OCEAN RESEARCH PROJECTS

CHAPTER I

1.0 OCEAN RESEARCH PROJECTS

This chapter presents an overview of the project management information specific to ocean research projects. The discussions that follow rely on the author's experience while working with the Newfoundland Oceans Research and Development Corporation Limited (NORDC), St. John's, Newfoundland. Where relevant, supporting information from other parallel organizations across Canada is provided. This overview is provided in three parts:

- Factors in Ocean Research
- Cost Breakdown of a Typical Ocean Research Project
- Project Information for Management

1.1 Factors in Ocean Research

The factors, both internal and external to NORDCO, which influence ocean research, are described in Figure 1 below.

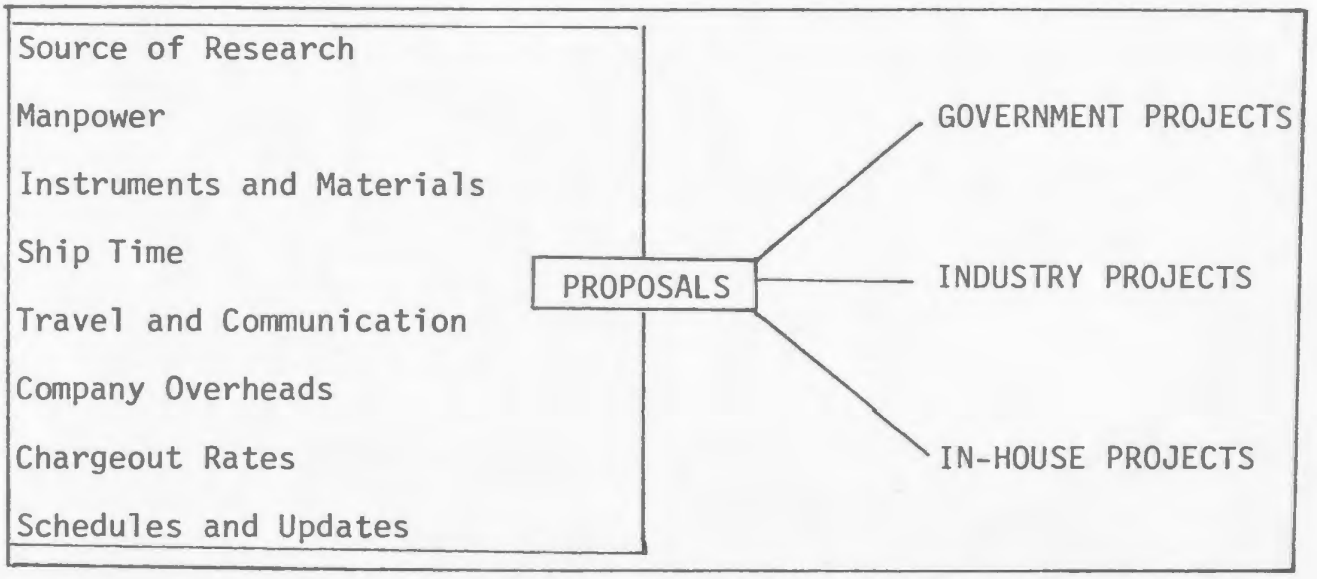


Figure 1: Factors in Ocean Research

Research activities of NORDCO emanate from either within the company or through external contracts. Company research effort is applied in writing of proposals and in conducting in-house projects. Proposals indicate the combination of factors which are applicable to any project. The cost of writing of these proposals is generally between 3-5% of the gross annual revenue of the company and is a necessary overhead expense. The present company policy encourages in-house research into potential revenue generating areas and also to keep the research staff profitably employed during the slack period of work, which here in Newfoundland is usually from November-April of each year. The external contracts (both government and industry) are obtained through competitive bidding and are the main source of revenue to the company.

The formation of the project team necessarily takes into consideration the suitability of each member of the team and his availability for the project. In carrying out the project, most staff are committed on more than one project either within their groups under their own Directors or as members in projects in other groups under other Directors in the company. Such matrix management situation warrants an identification of manpower on all the ongoing, planned and anticipated projects, both on chargeable and non-chargeable jobs. Manpower analyses based on the percentage of available and utilized manhours is an important index to the management of research.

$$I_E = \frac{\text{utilized manhours}}{\text{available manhours}}$$

where I_E is the manpower employment index.

The usual employment index of the researchers on projects varies with their hierarchical level in the organization. A personal survey of British Columbia, Ontario and Nova Scotia research organizations provides the following indices:

Position of Research	% Direct Employment in Research
Top Management	3-5%
Senior Management	20-30%
Managers	50-60%
Technologists	60-80%
Technicians	70-90%

In research organizations, the ratio of support staff to operational staff is generally 1:4*. Also, it is found that if 60% of all operational staff manhours are engaged in chargeable jobs, the research organization would recover its operating costs. To keep the researchers engaged at least at this optimum level of employment is, of course, a difficult task especially in Newfoundland where the market in ocean research is developing.

Ocean research projects use a variety of instrumentation. Procurement of the instrumentation not available in the company or lost during deployment in the field needs a considerable lead time to order or to

---

* Figures ascertained from an analysis of 1977 Annual Reports of British Columbia, Ontario and Nova Scotia Research Foundations, as well as through personal discussions with senior management at these institutions.

replace. This procurement also involves initially heavy outlays which affect company cash flow.

Under the present company policy, the oceanographic instrumentation of the company is depreciated over periods ranging from 2-10 years as dictated by the nature of each of particular instrumentation. Some of these instruments are superseded within their effective life span by more reliable and accurate models. These factors lead to a higher depreciation rate and to recover these costs, the rental rates of the company instruments are based at 10% of the capital cost of the instrument per month.

Ship time for research projects is expensive as the average cost of a research ship runs over $10-16,000 per day. Ship chartering to match the project progress needs close liaison with organizations that supply ships for scientific and research projects. It usually takes about six months of advance planning to guarantee a ship availability when required for the project. Sometimes a number of projects can be scheduled on one ship thus using ship time effectively and economically.

Research projects often necessitate liaison with other organizations involved in similar research. Personal visits may be necessary for site inspection, collection of data, on-site supervision of subordinates and so on. While some projects have a need for movement of personnel, others may be entirely planned and researched from within the office. Where researchers have to be away on certain projects, their absence may affect

the progress of other project(s) on which they may be committed simultaneously.

Company overheads comprise of fixed and variable costs. While the fixed costs are incurred by the company at its established level of business, the variable costs rise with the tempo of research activity. Fixed costs include items such as depreciation of instruments and equipments, staff salaries, insurance of company fixed assets, rental of business premises and other general office expenses, the variable cost comprise of items such as:

- Interest charges on interim financing
- Cost of writing proposals, etc.
- Staff recruitment and relocation
- Travel and communications
- Advertising and sales promotion
- Conferences and conventions
- Entertainment

Due to the high depreciation rate of oceanographic instruments and the difficulty of full utilization of researchers on chargeable jobs, the overheads in research organizations tend to range from 140-160%** of the actual project costs. NORDCO overheads are higher than the other

---

** These figures have been ascertained from Nova Scotia Research Foundation, Ontario Research Foundation and British Columbia Research.

research organizations across Canada due to its development expenses during its present period of growth. But the company is charging overheads at 140% rate and is absorbing the excesses in its developmental expenses.

A sizeable cost content of ocean research projects can be attributed to manpower costs. Indeed some projects comprise only the manpower costs. When contracting the project work with clients, the manhour content and other costs of the project have to be specified separately. This cost breakdown facilitates contract negotiations and the client is able to appreciate the research effort in terms of the various elemental costs of his particular project.

For cost estimates, the company uses chargeout rates per manhour. These rates take into consideration the actual payroll cost of the researcher including the fringe benefits that the company is obliged to contribute on his account as well as the company overheads. These overheads are assigned only through the chargeout rates. Other direct costs are charged to the client at actual costs plus 5% towards handling charges. To cover these expenses and the fee, the chargeout rates in ocean research organizations vary from 2.4 to 2.6 times the payroll cost of the researchers. Some organizations have their chargeout rates based on classification system wherein the researchers are grouped according to selected range of pay scales and professional skills. In this situation, the chargeout rates for each different group of researchers are standardized irrespective of any pay differentials that may exist in

their actual salaries. In NORDCO, however, no such groups have been developed and the chargeout rates are based on the actual staff salaries and are different for each researcher.

Use of this empirical figure in developing the chargeout rates is convenient in contracting but it does not indicate the real profit/loss situation for the projects. The company may assume that it is making-a profit on the basis of these chargeout rates, yet it may find itself in a loss at the close of the financial year. This can happen, for instance, if the overhead expenses are higher than the budgeted level. To guard against this pitfall, it is necessary to identify the overheads of the company separately and then to develop the chargeout rates. This is essentially an accounting function and is outside the scope of this present report. However, an analysis of the overall company profitability status and the profitability status of each individual project is necessary to provide essential feedback information on the company chargeout rates and to indicate corrective action in cost areas having an influence on the overall profitability.

In the individual project plan, research activities are laid to a time frame. An example of a typical project time schedule is shown in Figure 2.

The project schedule assists the manager in the control of work. Most of the project/proposal schedules are simple, involving one to ten activities and are sequential except in the case of larger projects

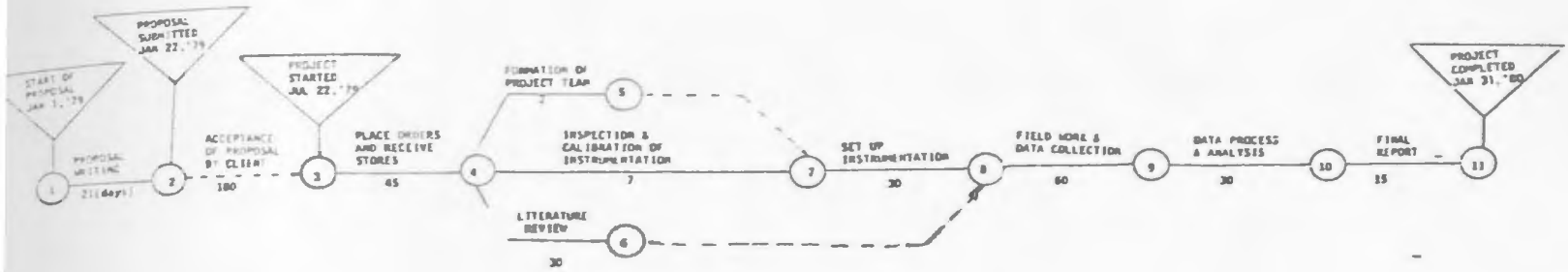


Figure 2: A Typical Project Schedule

with more than 50 activities which may require critical path scheduling. But the frequency of such big projects is not high for NORDCO contracts. Normally there are a number of small projects with one or two large projects at any one time. The planning process involves identifying the activities in each project, determining the start date, the likely completion date and often certain key dates during the project life. This plan facilitates monitoring the project progress. The individual project plans are integrated to form company plan. This overall project plan needs to be updated on a regular basis to take into account the changes and revisions in individual projects.

An ocean research organization requires a large and varied team of researchers to cover the wide range of its research activities. To meet this demand, the research organization recruits a core of permanent staff in its planned research areas. But for projects outside this expertise

and where the need for a specialist input is for a short duration and for a specific aspect of any project, the company engages the services of consultants or specialists. These specialists are generally busy people and require advance notice. They may even have to be contracted from outside the Province. In projects requiring the services of such consultants, it is necessary to know the type of specialists required, their availability and fee for the project plan.

From this description of research at the macro level, an attempt is now made at micro level to show the cost breakdown of a typical research project. The discussion on this aspect is presented in the next section.

1.2 Cost Breakdown of a Typical Research Project

The cost of ocean research projects essentially comprise direct cost of work performed in the office and the field, cost of subcontracts and consultants' work, and the company overhead costs. While the costs of office, field, consultants' work and subcontracts constitute the direct project costs, the company overheads are the indirect cost. The cost breakdown for a typical research project is illustrated in Figure 3. -

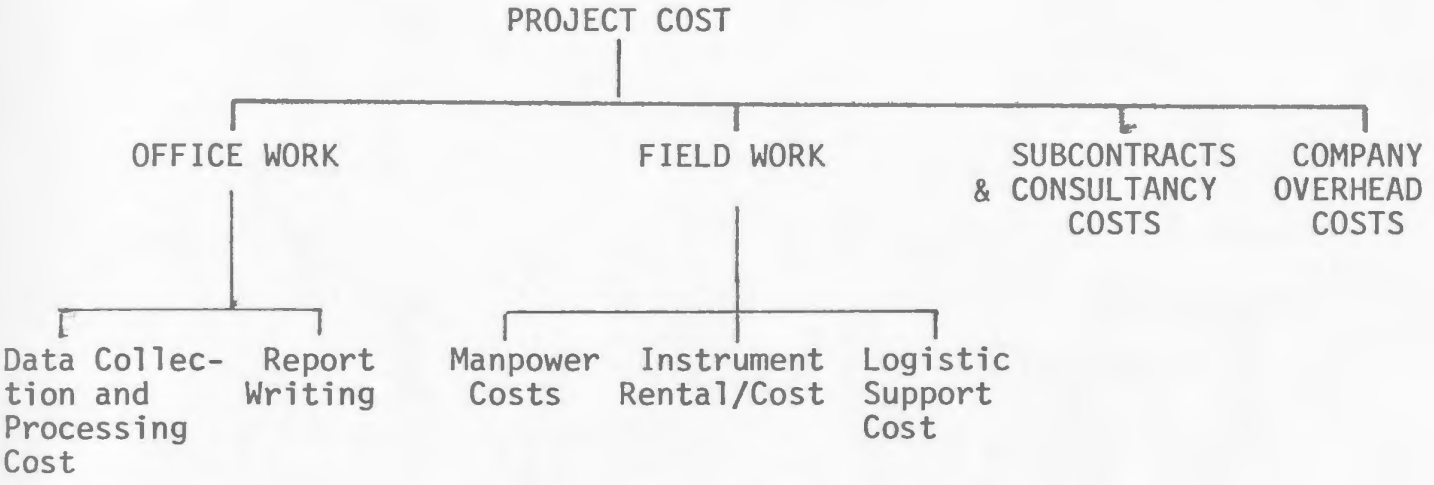


Figure 3: Cost Breakdown of a Typical Research Project

All research carried out within the premises of the research organization is classified as 'office work'. This is so because the chargeout rates for office work are different from those of the 'field work'. In NORDCO, office work is planned on the basis of seven working hours per day and the field work for ten working hours per day with no weekends. The chargeout rates in these cases are therefore different.

Problem investigation and data collection is a distinctive phase in the project plan. While problem investigation is carried out through literature search, the collection of main data is organized using company instruments. Sometimes this data may be made available by the client as part of the contract agreement. Also, at times, suitable data are purchased from other data collecting agencies. From whichever source the data are collected, its processing, analysis and interpretation is required. This work is mostly accomplished through use of computers and involves considerable manhours of researchers.

All research projects conclude with an operations report but interim reports may also be desired by the client. The contents and formats of these reports vary depending on client requirements. But generally, the final report outlines the methodology adopted, the results of the research effort, and recommendations to the client on its implementation/ influence on the overall research study. The report may even suggest further research into specified areas for a better understanding of the problem. It usually takes 1-2 weeks effort to assemble, compile and write this final report. The schedule and cost for this work is equally definable and influences the project cost.

Another component of project cost is the field work performed on the project. This cost element is by far the most expensive and needs careful planning to minimize field operations. Manpower costs in the field are higher on account of longer working hours per day, travel to and from the project site, compensatory allowances and for work performed on holidays

and weekends. In addition to these manhour costs are the related costs incurred on instrumentation. Many varieties of instruments are deployed in the project area over extended periods of time. Besides their rental or total cost charged to the project, the cost of shipment and deployment of these instruments is also substantial.

Logistic support for field work is expensive and time consuming. The backup support needed for the movement of new materials, instrumentation and manpower, their sustained deployment coupled with the maintenance of good communication link with them from the company head office falls in the realm of logistic support. Part of the cost of these activities is included in the company overheads while the balance costs are directly chargeable to the project.

Not all types of work can be performed using the company resources. Some aspects of research needs, integral to the overall project plan, which do not fall within the scope and potential of the company, are sub-contracted to other agencies having the required expertise. Also sometimes the company itself becomes a subcontractor to another main research organization which has successfully negotiated the contract.

While subcontracts are discreet packages of work, consultants work directly with the project team as per need. In either subcontract work or in utilizing the services of a consultant, a lump-sum or cost plus contract is negotiated. In cases where the projects need the services of consultants or some work elements are subcontracted, the cost and work

plan of these agencies need early development.

The chargeout rates for manpower and instrumentation are standardized for invoicing the clients and include a portion of the company overheads. Delineating overhead costs for individual projects is an accounting function in NORDCO.

In the light of the overview provided in Section 1.1 and the cost breakdown of a typical research project provided in this Section, it is now possible to identify the project information required by the management in effective performance control. The information packages for various levels of management and a brief description of them is presented in Section 1.3.

1.3 Project Information for Management

The project management system for NORDCO has been designed to:

a. Integrate individual projects (proposed and in progress), proposals and other research activities into an integrated project plan.

b. Co-ordinate the work of project team leaders for optimum resource utilization.

c. Update the project schedules at regular intervals and provide the management with the latest information on all projects.

d. Monitor the project progress and expenditure during its execution.

The essential elements of this information are shown in Figure 4.

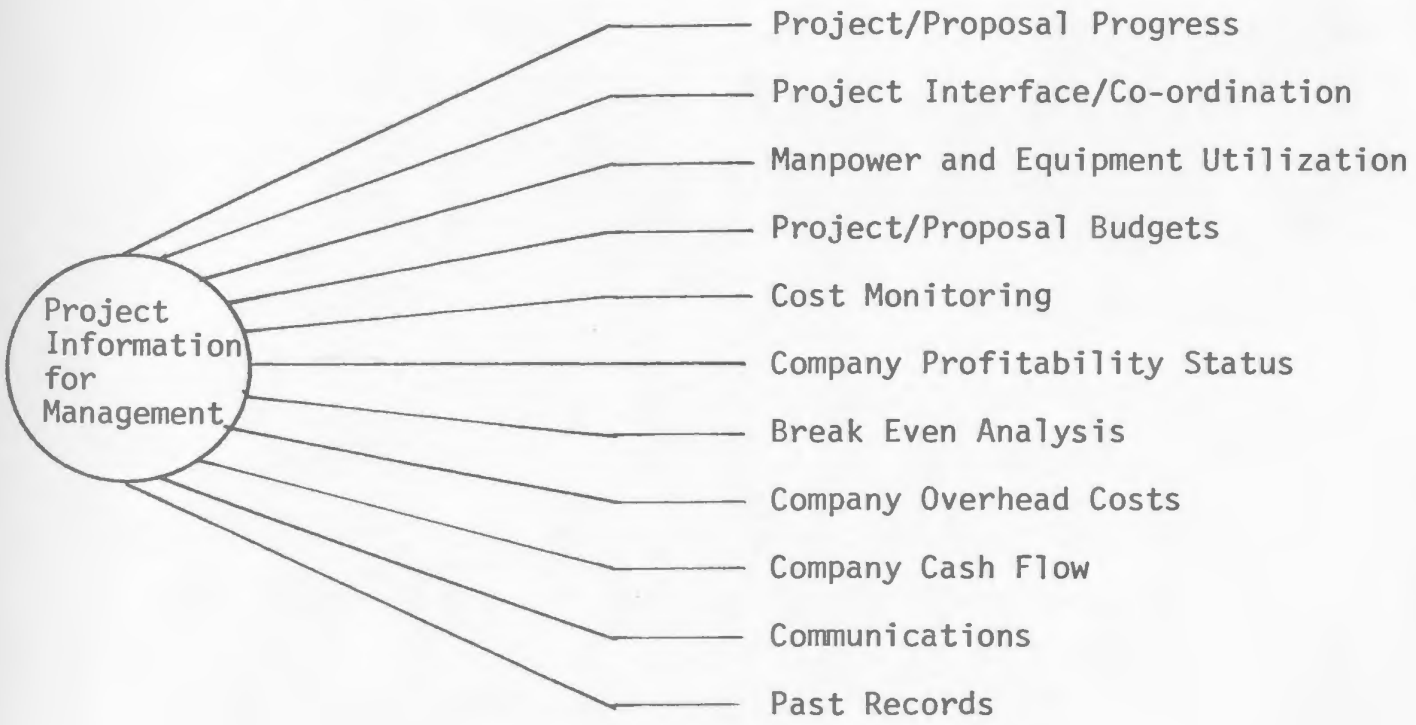


Figure 4: Elements of Management Information

In multi-project situations such as in NORDCO, many a time the progress on some research is dependent on the information interface from another project(s). Manpower and instrumentation utilization affects project cost and need a careful watch. Sometimes, the operating personnel need familization and may have to go through special training cadres. Commitment state of the company resources helps to take accurate decisions on purchase, lease, rent out, or sell idle or underutilized resources.

Company budget is developed through individual project budgets. It is necessary to develop financial models that indicate the profitability status of the projects individually and also collectively for the company. Cost variances can then be localized for suitable remedial measures while the project is still ongoing. This is an important function of cost engineering, which is dynamic in its application and approach. It differs from the function of cost accounting, which essentially relates to the maintenance of accurate financial records. Company profitability can be developed through the difference of cost and revenue as described in Figure 5.

REVENUE	EXPENDITURE
Manpower cost at chargeout rates	Manpower costs at payroll rates
Instrument rentals at company rates	Instrument depreciation and maintenance costs
Material costs plus handling charges	Material costs
Consultancy expenses	Consultancy expenses
Any other special expenses	Company overheads

Figure 5: Revenue VS Expenditure

The difference between the revenue accruing to the company and the cost of meeting the contractual and company expenses indicates the profitability status of the company at a given time. A typical profitability model for a fixed price contract is shown in Figure 6.

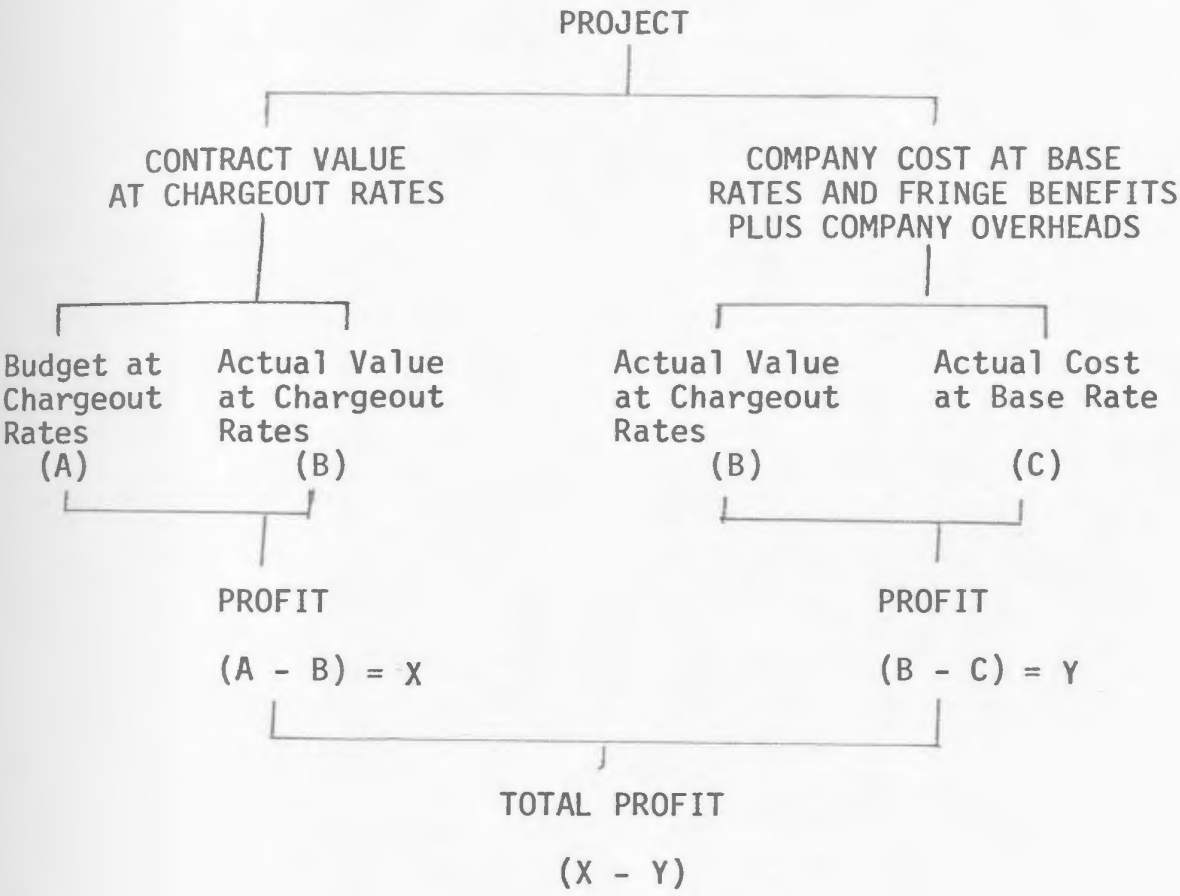


Figure 6: Profitability Model

For maximizing profitability there is a need not only for an efficient technical, administrative and financial control but also for evolving an efficient research design to obtain the desired results. This requires a high level of professional competence of the research staff.

A model showing the influence of efficiency of research design on the profitability of projects is shown in Figure 7.

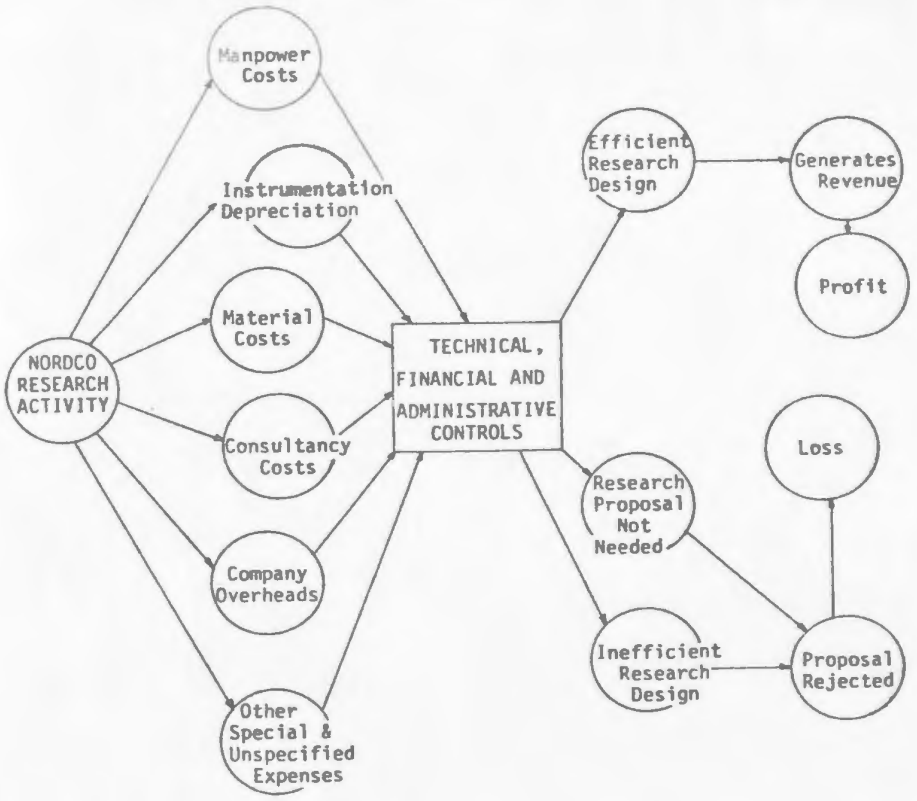


Figure 7: Profitability Elements

Company break even analysis is often necessary to ascertain the minimum value of business to cover the operating expenses. For this, the current and anticipated project/proposal volume is worked out and compared to the company costs (fixed and variable). A break even analysis model with its rationale is shown in Appendix A.

For undertaking the planned level of research work, it is necessary to see that the project plans are physically feasible. It is also necessary to see that the funds required to execute the research are available. On any project there is an inflow as well as an outflow of cash. While payments received from clients and government grants comprise the inflow, progress payments are made to the researchers, consultants and others constitute the outflow.

Just totalling the revenue receipts and costs incurred is not sufficient by itself to give a clear picture of the total financial involvement of the company. A net surplus of revenue at the end of the project does not necessarily make easy the task of carrying it out successfully in financial terms. It would be essential to have a company cash flow analysis which will take into consideration the actual cost to date, commitments and projected expenditures over the entire span of the specified time period in relation to the revenue receipts. A graph of cumulative expenditure less revenue against project time in months is shown in Figure 8.

The necessary input data for the company cash flow consists of project schedules, estimated cost of each activity, progress payment, time lag factors for the various income and expense component. Net cash flow forecasts for the company research for a certain period of time are obtained from the combined income of all research projects and their direct costs and overhead expenditures. Since all research projects are planned on a time frame, this may be modified to match the availability of funds.

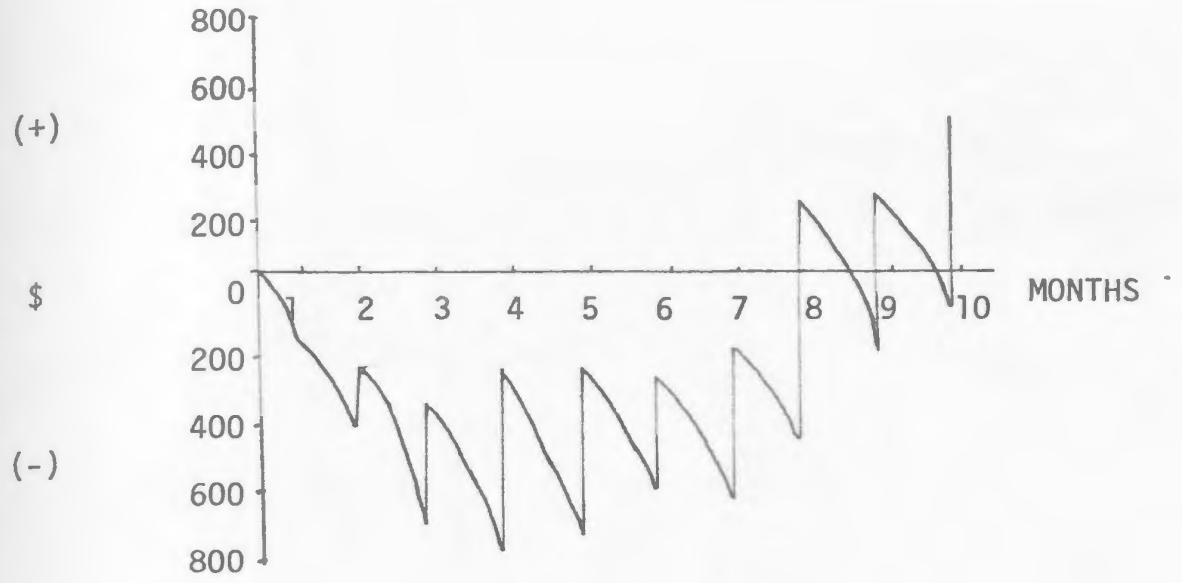


Figure 8: Cash Flow Graph

The information flow design determines which information each person requires and at what level of detail. For example, top management is concerned with having current information on major aspects of each project. The higher the person is in management, the more concise reports he needs. The information system facilitates management decisions as a natural outcome of the process. Sifting information into packages suitable for different echelons of the company management is essential. To develop such an information flow system for NORDCO, a detailed study of the functional responsibilities at different levels of the organization is necessary. This necessitates the study of the company organizational structure as well. In this context, a brief organizational structure of NORDCO is presented in Appendix B.

Maintenance of company records with detailed accounts of project cost elements, project cost categories, and project durations is important. But these cost records cannot be directly extended to other projects easily since each research project is a unique combination of researchers and support elements. Past records at best can be a useful guide for planning and estimating future works. It would naturally take a considerable length of time to develop a library of such data which would provide the necessary confidence in its reliability, but a start need be made as early as possible for benefits at a later date.

The discussions in this chapter lead to the specific information requirements of the management based on their functional responsibilities in NORDCO. These discussions are provided in the next chapter (Chapter II).

CHAPTER II

PROJECT PERFORMANCE CONTROL

CHAPTER II

2.0 PROJECT PERFORMANCE CONTROL

The main areas of responsibility of NORDCO management towards company research are shown in Figure 9 below:

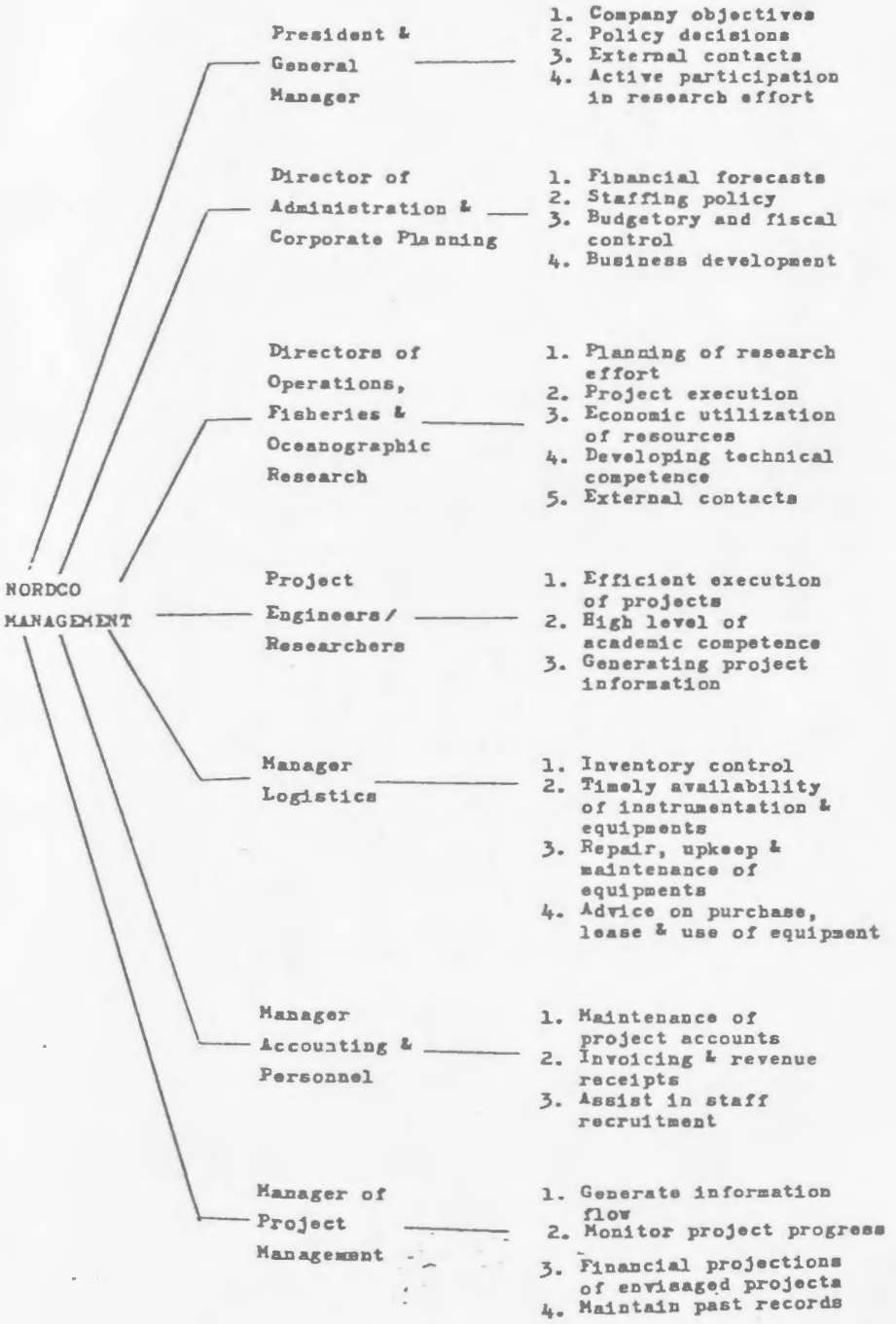


Figure 9: Management Areas of Responsibility

In the discharge of these responsibilities, company management and researchers alike need a continuous flow of information on projects underway in areas such as schedules, resources, cost, research interfaces and so on. While the top level of management control research activities through the rule of 'management by exception' requiring research information in a summary form, the lower and middle management need research information in varying degrees of detail appropriate to their job responsibilities. Most of the questions that exist in the minds of management in their work performance have been identified for different levels in the organizational hierarchy and are listed in Appendix C. These questions essentially relate to schedules, resources, budget and cash flow.

2.1 Information Packages

The information packages for NORDCO comprise of standard and adapted PMS IV reports as well as specially prepared manual reports. Out of the total of 96 different types of standard reports available in the PMS IV package, only seven have been selected for the Company. These reports have been developed using selection criteria and suitable adaptations (a description of these techniques is provided in the next chapter, Chapter III). One report (Cash Flow Analysis) is developed using the input from a PMS IV report and the information obtained through project contract documents. Another four reports are developed manually, of which only two are being used at the present time. The remaining two manual reports have been conceived but cannot be put to use owing to the lack of adequate information available in the Company at this stage of development and growth. Altogether these twelve reports have been designed to provide

sufficient information to the management in effective project control. A brief description of all of these twelve reports follows and specimens of each of the nine reports in use at NORDCO are shown in Appendices D1-D10.

Work Plan Report (PMS IV)

The Work Plan Reports list the various activities of the projects and indicate their start, duration and completion dates. Important dates of these projects are flagged to provide a comparison of the actual and planned project progress.

Work Plan Reports for senior management, having the responsibility of co-ordinating several projects concurrently, are planned at summary level for each of the projects/proposals under their direct responsibility. These summary level reports provide key information on the research such as scheduled deadlines of the negotiated contracts, start and completion dates of projects, schedules of research interfaces, etc. The project managers who are actually in charge of carrying out the projects get the Work Plan Reports at detailed level wherein the schedule information on all the activities of the research are provided.

A specimen Work Plan Report is shown in Appendix D1.

Cost Category Status Reports (PMS IV)

Cost Category Status Reports provide project cost information broken down into four cost categories of:

(a) Proposals

(b) Government Projects

(c) Industry Projects

(d) In-House Projects

Within these cost categories, the Cost Category Status Reports present the current picture and outlook for manhours and total costs of each project and compare it to their budgets. Grouping project costs in this manner provides a useful means of analyzing company research costs in terms of these cost categories.

A specimen Cost Category Status Report is shown in Appendix D2.

Rainbow[1] Category Status Reports (PMS IV)

For each of the four cost categories of research listed above, there are a further eight elemental costs namely:

(a) Manpower Costs

(b) Materials (including transportation) Costs

(c) Travel Costs

(d) Instrument rentals (receivable by NORDCO for its own instruments)

(e) Rentals from outside agencies (payable by NORDCO on instruments rented by it from external sources)

(f) Computer Costs

---

1. 'Rainbow Category' is a PMS IV nomenclature for defining the elemental costs within the cost category costs. For details refer to Report Processor Manual #SH20-0901-2.

(g) Consultants

(h) Subcontracts

Rainbow Category Status Reports provide cost breakdown of each project/proposal in these cost elements and present the current picture and outlook of project costs, the total costs and compare them to the budgeted costs of these elements. By grouping together similar elemental costs of all company research, management is able to ascertain the distribution of costs within the Division/Company total research at any given time.

A specimen Rainbow Category Status Report is shown in Appendix D3.

Organization Status Reports (PMS IV)

These reports present the manhour and direct costs of the projects/proposals which are shown as actual manhours to date, planned manhours and totals at completion; actual direct costs to date, planned costs and the totals at completion. It also shows the projected overruns/underruns for each manpower resource and elemental cost.

These reports in summary form are provided for the senior management. For example, for each of the Division Directors, the summary level reports group the projects under the particular Division and provide the consolidated research cost information. Likewise for the company head office, a consolidated summary report is obtained for all company research at any given time.

A specimen Organization Status Report at detailed level is shown in Appendix D4 and a summary level report at Division level is shown in Appendix D5.

Financial Plan and Status Report (PMS IV)

These reports present an accounting-period-by-accounting-period (every one month interval for NORDCO) comparisons of actual costs incurred by the Divisions against their planned costs for the given periods. In this manner, it serves as a financial monitoring tool. Prior accumulative costs are shown by period for each Division. Only Divisions active in research during any particular accounting period are reported upon. Costs are totalled up from individual project costs.

A specimen Financial Plan and Status Report for NORDCO is shown in Appendix D6.

Management Summary Reports (PMS IV)

These reports present the current, budgeted and projected manhour costs of all projects and proposals. Summary level reports are obtained for all planned and utilized manhours by Divisions and also for all projects within the Divisions. Since direct costs are not included in these reports, they show only the manhour costs. This report is therefore particularly useful to NORDCO management in ascertaining the gross revenue accruing to the Company based on the utilized manhours on the projects for the specified period of time.

A specimen Management Summary Report is shown in Appendix D7.

Program Outlook Graphs (PMS IV)

These graphs display the budgeted and actual costs of projects against project durations. For each project a separate graph is obtained. The use of this graph is limited to larger projects which are executed over extended periods of time. The time and dollar scales of these graphs can be varied to meet the needs of the particular projects.

A specimen Program Outlook Graph for a NORDCO project is shown in Appendix D8.

Manpower Utilization State (Manual)

These reports provide the management with a complete breakdown of the Company manhours which have been utilized on chargeable, non-chargeable research as well as on administrative functions during the preceding one month. The chargeable manhours are further divided amongst project cost categories viz proposals, in-house projects, government projects and industry projects. Similar manhour breakdowns are also prepared for the Divisions. These reports have proved very useful with the management in providing visual images of the distribution of available and utilized man-hours of their research staff.

Specimen diagrams in the form of pie graphs representing manhour utilization state for a one month period for NORDCO and the three operating divisions are shown in Appendix D9 (annexures i to iv).

Manhour Utilization Trend Graphs (Manual)

These graphs essentially draw information from the Manhour Utilization State graphs. Here the same information is plotted on continuous graphs by months and provide a month by month comparison of the manhour availability with utilization and thus an index of effectiveness of manhour planning and utilization. By narrowing the gap between the total available manhours with those utilized, the non-profit manhours can be minimized through a greater awareness generated by these graphs. Similar graphs are also prepared for the Divisions.

A specimen Manhour Utilization Trend Graph for NORDCO is shown in Appendix D10.

Cash Flow Analysis (PMS IV and Manual)

Cash Flow Analysis report is developed through an integration of the information contained in the Financial Plan and Status Report (PMS IV) and the payment schedules of revenue generating projects as obtained from the contract documents. These reports are necessary for projects involving heavy outlays which may effect the established cash flow of the Company. Many projects may seem possible in terms of revenue surplus, but may run into short term cash difficulties in their execution because of expenses involved at intermediate stages of progress which are later reimbursed by the client. To gain a clear picture of the financial 'dips' in the execution of major projects, these Cash Flow Analyses are often asked for by the management.

In developing Cash Flow Analysis, the actual costs to date, commitments and the projected expenditures as well as the revenue receipts and time lag factors over the entire span of the project time frame are taken into consideration.

Manual Reports (Not in Use)

The two manual reports conceived by NORDCO which have not been used as yet are:

(a) Overhead Costs

(b) Break Even Analysis

Overhead costs are essentially developed from the operating expenses and the expected volume of business. In costing projects, it is often necessary to ascertain the overhead cost per manhour of the researchers on any project. By developing project costs in this manner, it becomes possible to develop profitability analyses of the projects and of the Company.

The actual overhead expenditure is collected under different headings such as salaries, travelling, rent, telephone, and so on. Feedback for control of overheads consists of monthly statements of expenditure comparing actual expenditures with their budgeted provisions. An evaluation of Company performance in terms of efficiency, productivity and costing of projects is possible through projected and actual research and profit volumes. These analyses in reverse then indicate the overheads of the company related to company manhours.

To develop the break even analysis point, it is necessary for the management to define its planned level of operation. This is difficult for NORDCO because of the interplay of many factors external to the organization. Some of the factors affecting the planning process are such as government policy on the research level of offshore petroleum industry in this region, the intensity of major explorations during any time period, etc. Unlike B.C., Ontario, and Nova Scotia research organizations, NORDCO does not have any appreciable demand from the local industry for its consultancy services.

For the Company to be a viable economic unit at its present level of operations, the overheads and the in-house costs must balance the profit earned through the revenue generating projects. But to establish itself as an important research centre, NORDCO has maintained a staff of researchers well over its present revenue potential leading to higher operating costs. This investment is considered necessary at this stage of growth because it takes considerable length of time to develop teams of researchers to undertake work in specific areas of research and to attract qualified and experienced professionals at short notice at this location. This difficulty is coupled with the initial capital expenses making it difficult to develop any break even point. However, an effort has been made to set up the mechanics of developing such an analysis whenever the Company operations have stabilized. A suggested break point model is shown in Appendix A.

2.2 Information Analysis

The reports discussed in the previous sections together with the user requirements are now correlated to form an Information Analysis Table for NORDCO. This table gives a listing of NORDCO levels of management, the types of project information required by them, the frequency of this information and the source through which these reports are developed. This information is shown in Table 1.

2.3 Acceptance of the System

One of the main problems in implementing the management information system in NORDCO has been its unwilling acceptance by the researchers. These researchers are more interested in their project work and like to remain as much away from the 'superfluous' project and administrative details as possible. Information inflow to the central co-ordinating agency (Manager of Project Management) and its outflow to the different echelons of management depends heavily on this acceptance. Since NORDCO did not have any formalized reporting procedures, enforcement of any structured information procedures, however informal, had a cautious reaction from the staff. This was quite natural as without the benefits of such an imposed discipline to their work performance, it was easily passed as 'one more chore'.

To overcome this problem, a series of seminars and forums for discussions were organized to achieve awareness of the advantages of the system and to familiarize all concerned with project management terminology. Many actual project reports were discussed in hindsight to demonstrate

Table 1

Information Analysis Table for NORDCO

	Management Information Needs	Source of Information	Type of Report	Frequency	Recipient	Use
1.	Project/Proposal progress Project interface/co-ordination Project/Proposal schedules	PMS IV (NP)	Work Plan Report (Report 13: NP)	Once a month	Project Managers Directors Manager Accounting & Manager Logistics President & General Manager	Detailed level reports. Help to monitor project/proposal progress Summary level reports for information and project control
2.	Project/Proposal budget VS work performed to date Cost monitoring	PMS IV (CP)	Organization Status Report (Report 50: CP)	Once a month	Project Managers Manager Accounting	Monitor project costs Client invoicing
3.	Project/Proposal budget summaries VS work performed	PMS IV (CP)	Summary Organization Report (Report 55: CP) Program Outlook Graph: Time VS Dollars (Report 80: CP)	Once a month	Directors of Operating Divisions	Overview of work progress
4.	Breakdown of project/proposal into cost categories Breakdown of project/proposal into cost elements	PMS IV (CP)	Cost Category Report (Report 38: CP) Rainbow Category Report (Report 39: CP)	Once a month	Director of Administration & Corporate Planning	Cost Analysis

Table 1 (cont'd)

	Management Information Needs	Source of Information	Type of Reports	Frequency	Recipient	Use
5.	Company financial summaries	PMS IV (CP)	Management Summary Reports (Report 36: CP)	Once a month	Directors of operating divisions	Monitor Division budgets to work performed
					Director of Administration & Corporate Planning	Monitor Division work performance
					President & General Manager	Evaluate Company work plan
6.	Company cash flow	PMS IV (CP) & Manual plot	Financial Plan & Status Report by Period, Summary Charge Number (Report 41:CP)	Whenever required	Directors of operating divisions	Balancing work flow to cash flow
					Director of Administration & Corporate Planning	
					President & General Manager	
7.	Manpower & Equipment Utilization State	Manually	Pen Diagram & Graph (Manual)	Once a month	Directors of operating divisions	Monitor resource use trends
					President & General Manager	
8.	Company Profitability Status	PMS IV (CP) & Manual	Management Information Summary & Graph (Report 36:CP)	Once a year	President & General Mgr.	Profitability status of the Company
					Director of Administration & Corporate Planning	

Table 1 (cont'd)

	Management Information Needs	Source of Information	Type of Reports	Frequency	Recipient	Use
9.	Company Breakeven Analysis	Company financial statements. Data made available by the Accounts Dept	Breakeven graph (manually plotted)	Once a year	President & General Mgr. Director of Administration & Corporate Planning Directors of operating divisions	Balancing work load to breakeven point and beyond
10.	Company Overheads	Project/proposal performance Effective manhours utilized over the period	(Manually computed)	Once a year	President & General Mgr. Director of Administration & Corporate Planning Directors of operating divisions	Costing of Company works and for competitive bidding.
11.	Historical Data	All of the above	All of the above	Continuous	Company Records	Cost analysis of Company performance during the preceeding period. Developing future projections.

the benefits of the system. Further, an information system flow model was designed through the active participation of researchers. This information flow model is shown in Figure 10. Manager of Project Management is the focus of information system and acts as the nerve centre of the whole information flow process.

To become associated with the project planning at its very early stage, a project planning procedure has been developed. This procedure makes it obligatory for all researchers to get involved with the planning of their project schedule, budgets and resource requirements prior to the commencement of their research work. The researchers discuss their project plan somewhat informally with the Manager of Project Management and then obtain the project approval from their respective Directors. Project account number to accumulate all authorized project costs is allotted as the last step in the whole process of approval. This arrangement provides full control to the Directors regarding the research under their charge. The planning procedure in use by NORDCO is shown in Figure 11.

2.4 Past Records

A few words on the maintenance of project performance records are considered appropriate at this point. To reap the benefits of experience in project planning and execution, much consideration has been given to the collection and maintenance of suitable project information on completed projects. Analysis of such information provides a meaningful input to present and future planning. A model of feedback based on the past performance on projects is shown in Figure 12.

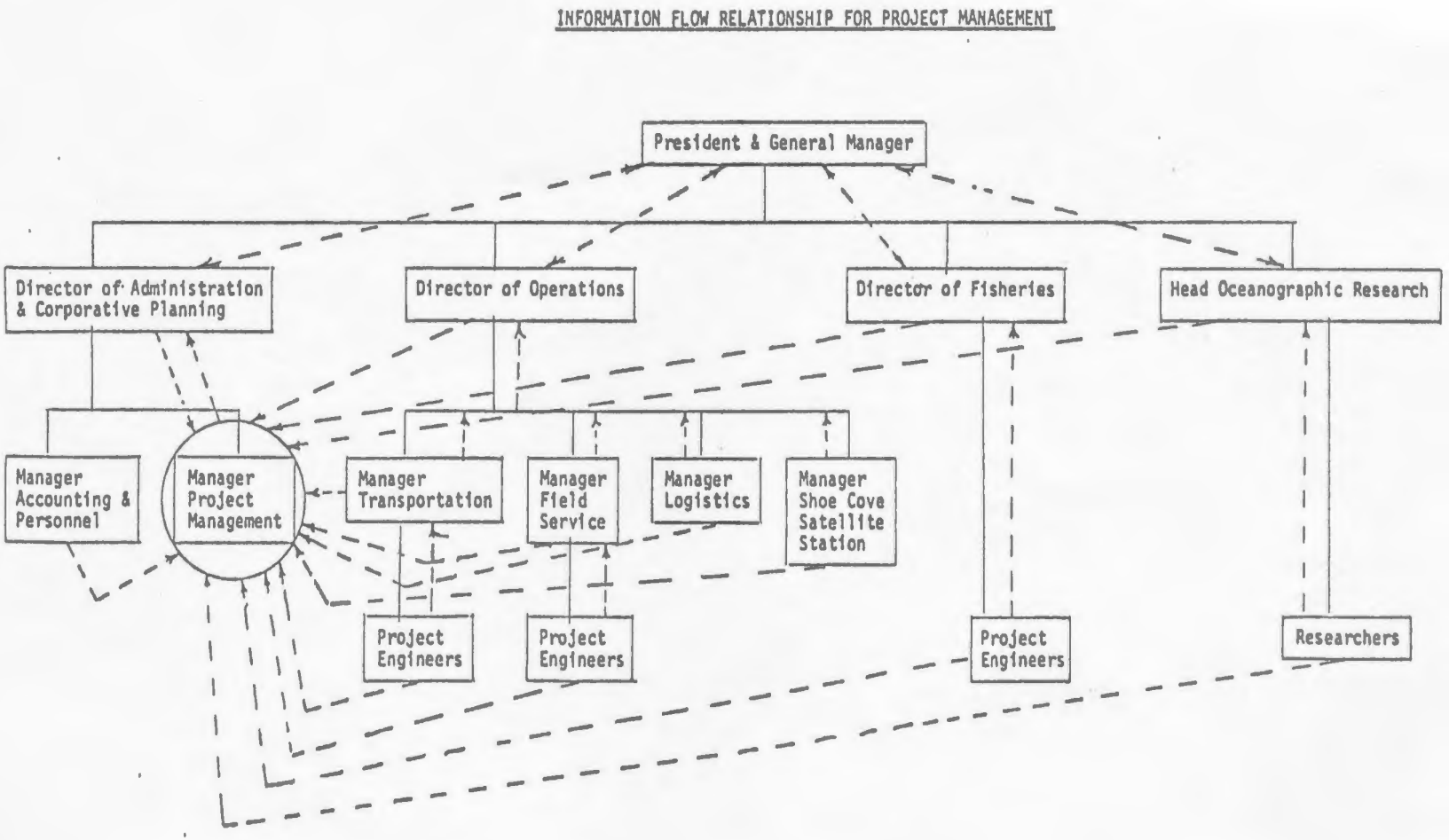


Figure 10: Information Flow Design

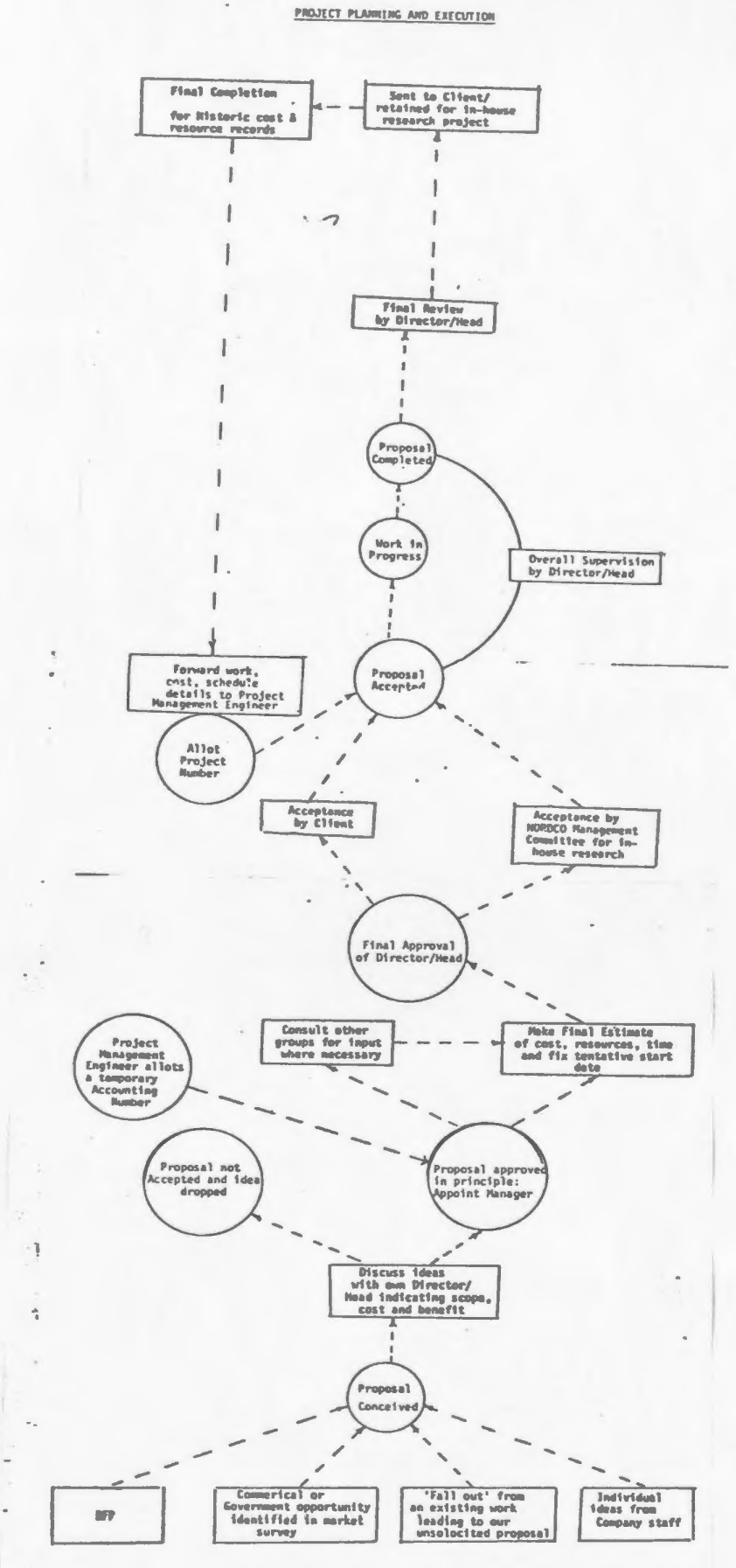


Figure 11: Project Planning Procedure

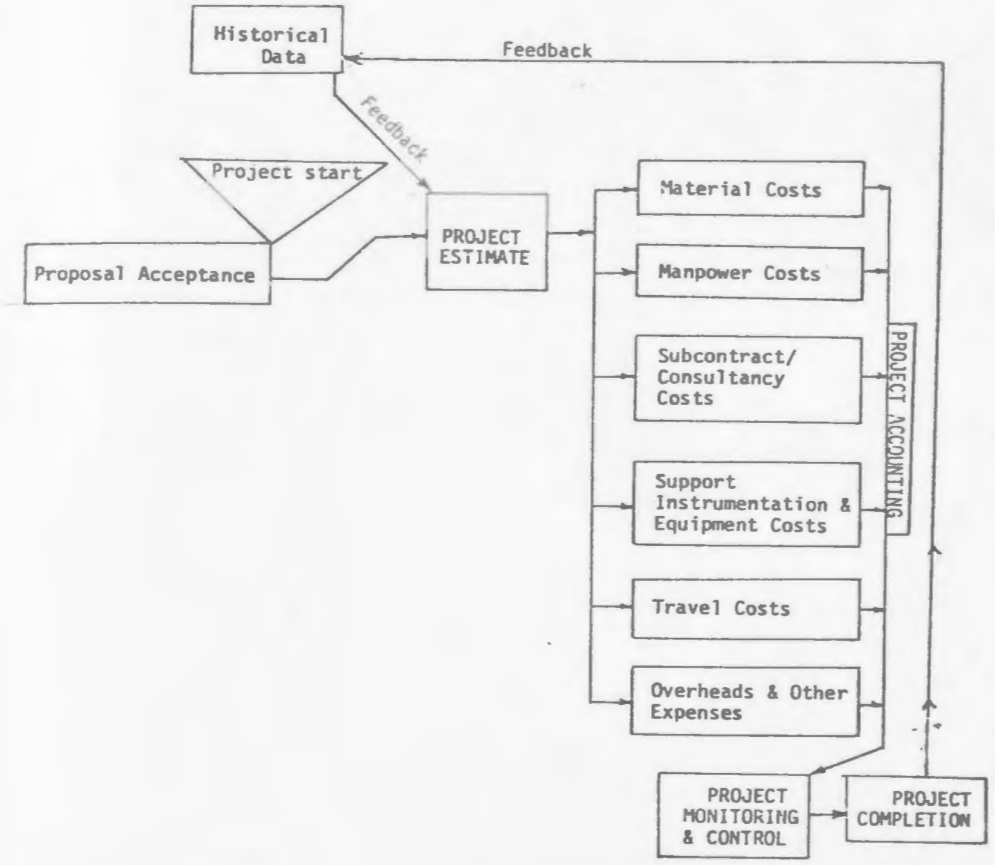


Figure 12: Project Information System Feedback Loop

Besides the conceptual framework of this need, not much success has been achieved in this area. The main reason has been the present diversity of research in the Company affecting short term benefits. But it is the author's belief that these records will be invaluable to the Company in the long run.

So far no mention has been made of the actual mechanics of obtaining reports through the use of PMS IV computer package. The next chapter, Chapter III, deals exclusively with technical details of this package and the adaptations made therein to achieve the desired results.

CHAPTER III

DESCRIPTION OF NORDCO MANAGEMENT SYSTEM

CHAPTER III

3.0 DESCRIPTION OF NORDCO MANAGEMENT SYSTEM

The project management system developed for NORDCO is based heavily upon an existing computer program of IBM named Project Management System IV (PMS IV). This package has a highly modular set of program routines and is open ended allowing the number of functions to be expanded and added to meet user requirements. The program is written in Assembler Language. In this chapter the modules of the PMS IV system are explained briefly, the difficulties in using the package in its standard form for NORDCO research projects are identified and the project management model for NORDCO is described.

3.1 Modules of PMS IV

There are four modules (Processors) of PMS IV viz Network Processor, Cost Processor, Resource Allocation Processor and the Report Processor. The place of these four modules of PMS IV is shown in Figure 13.

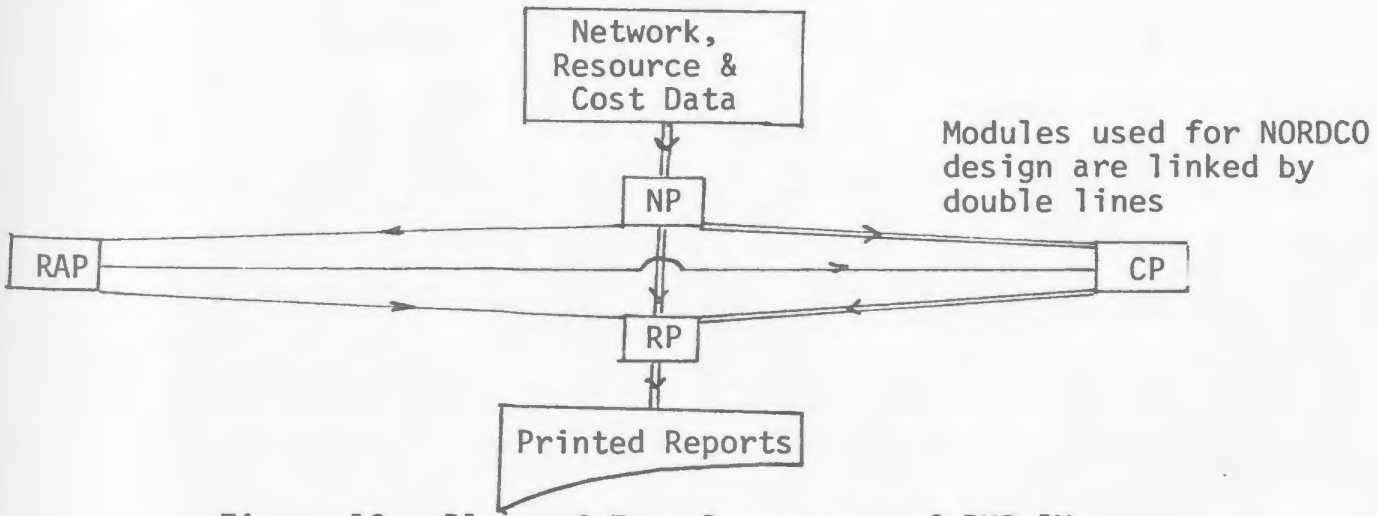


Figure 13: Place of Four Processors of PMS IV

Network Processor (NP)

The activities of the research projects are linked together to reflect sequencing dependencies either in series, one following the other or in parallel, concurrently or with overlap. These activities are assigned time estimates for their completion and carry an activity description. The junction point of these activities indicating the beginnings and endings are conventionally called 'nodes'. The network of the research projects represents this time-dependent relationship among its activities and serves as a framework for tying together the time, cost, and resource elements of the projects. It also provides a basis for measuring cost accomplishment against management objectives. The Network Processor performs the CPM/PERT analysis of these project activities. It edits the input and creates or updates from it, an edited master file for use by the next module namely the Cost Processor. A typical network of a research project is shown in Figure 2 (Chapter I).

Cost Processor (CP)

The Cost Processor performs calculations required in the project cost management. The cost of project activities is developed based on manpower, instruments, and other direct and indirect costs to complete the activity within its allocated duration. These cost estimates are affected by both the elapsed time and the estimated duration. Comparisons made of the actual costs incurred for each activity with its current estimates establish the cost status and identify any incurred cost overruns. Estimates of costs for portions of activities not yet performed are also obtained to predict future cost overruns and to identify difficulties in completing

the activities within their stipulated times. The time frame for all activities of research projects for a time-cost analysis is provided by the Network Processor.

Resource Allocation Processor (RAP)

The Resource Allocation Processor is not used at the present level of NORDCO operations as the number of resources (60 researchers and 100 instruments) is not large enough for economic computer applications. RAP provides many possible resource allocation decisions in terms of cost effectiveness and time schedules. The use of this processor is important for large complex projects where accurate management decision on the allocation of resources, concurrently planned on several activities, is required from among the several alternatives. In processing project resource data, the RAP takes its input from the Network Processor and the Cost Processor.

Report Processor (RP)

The Report Processor has built in routines and procedures to produce 96 standard reports using the processed data from either of the NP, CP and RAP modules either singly or collectively. Modifications and adaptations of these standard reports are possible. The contents of the reports use the standard format of reporting but this format can be customized where required. The reports developed for NORDCO had their contents modified to meet requirements of the Company.

3.1.1 Subroutines & Links of the Cost Processor Module

The design of the Cost Processor needs more care since the project

costs and the management report designs are affected by the way the activity costs are organized, processed and accumulated. To accommodate the many variations that are possible in grouping project costs, the CP has three subroutines and two cost links. The subroutines arrange each cost by project, operating Division and its cost category. These subroutines are called the Work Breakdown Structure, Organization Analysis Table and the Cost Analysis Table, respectively. The cost links provide the flow path to activity costs under each of the three subroutines. This arrangement is explained in Figure 14.

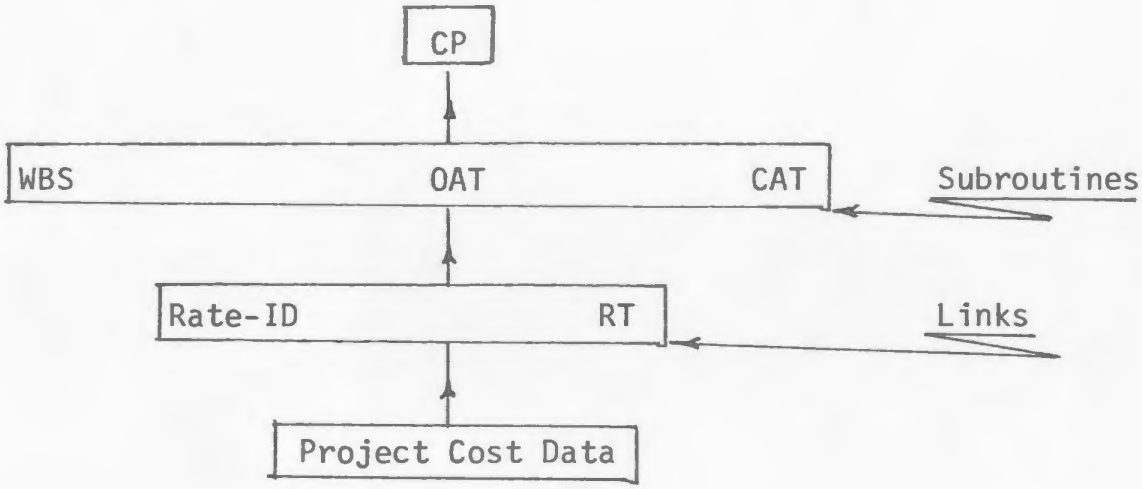
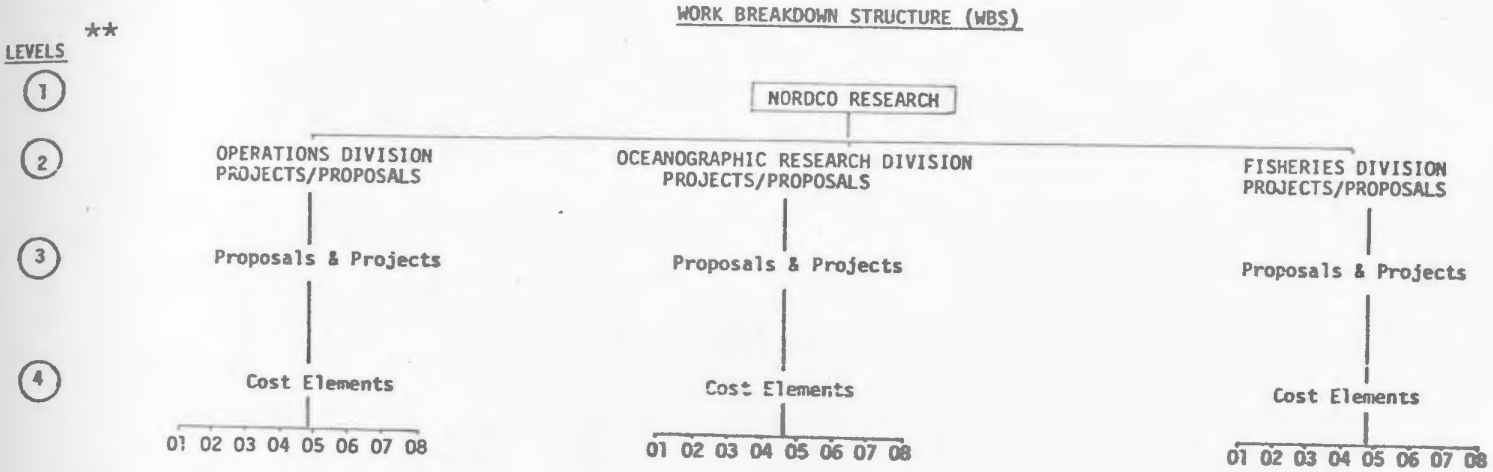


Figure 14: Cost Processor Subroutines & Links

Work Breakdown Structure (WBS)

The breakdown of research into distinct cost packages is achieved by developing a Work Breakdown Structure. For NORDCO, the research is divided among the three operating Divisions. Within these Divisions, the research is further divided into proposals, industry, in-house and government projects. These projects are still further broken down into eight

elemental costs. Breaking down research in this manner leads to the development of the WBS and the design for NORDCO is shown in Figure 15. The summarization capability of the CP enables the research costs to be added and totalled at different levels to provide project cost reports as required by management. The WBS for NORDCO has four levels as shown in the Figure. In PMS terminology each activity cost is termed as the 'charge number' and each project is called the 'work package'.



** ① NORDCO Research ② Divisional Research ③ Projects

④ Elemental Cost

Figure 15: Work Breakdown Structure for NORDCO

Organization Analysis Table (OAT)

In a similar manner to the research breakdown, the organization is subdivided along functional lines. The operating Divisions, called the 'performing departments', are responsible for controlling their research. This responsibility jurisdiction facilitates grouping of information reports within the Company. An OAT for NORDCO is shown in Figure 16.

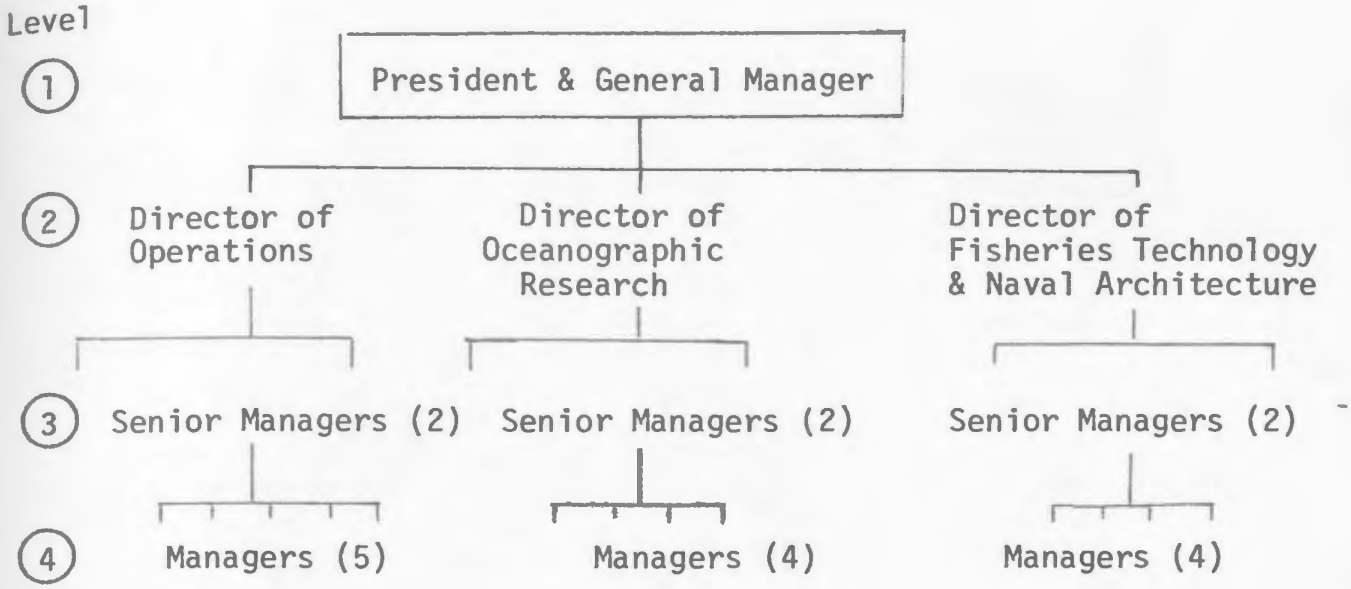


Figure 16: Organization Analysis Table for NORDCO

Cost Analysis Table (CAT)

The Cost Analysis Table classifies costs into their defined cost categories which for NORDCO research are Proposals, Industry, In-House and Government projects. Within these cost categories, the costs are subdivided into elemental costs which are assigned distinct cost codes. The CAT for NORDCO is shown in Figure 17.

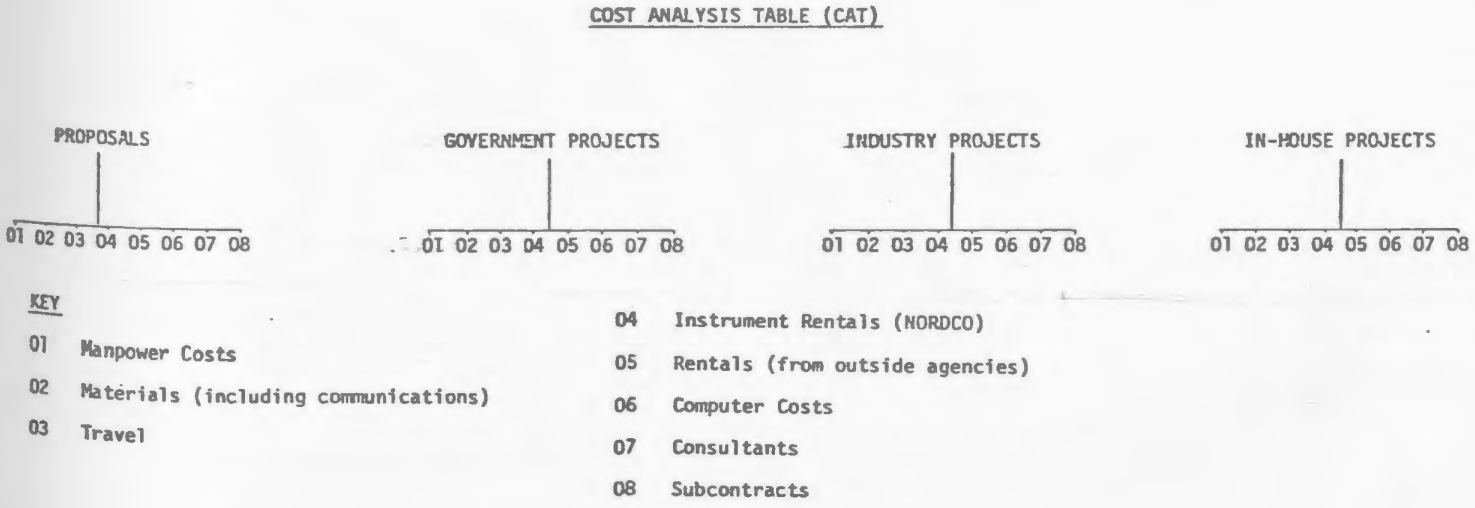


Figure 17: Cost Analysis Table for NORDCO

The account code structure as shown in CAT (Figure 17) is used in collecting costs under different 'charge numbers' and 'work packages'. These costs are later summarized for each operating Division as well as for NORDCO.

Rate-Identifier (Rate-ID)

Rate-Identifier is one of the two 'links' in the Cost Processor. For every cost record submitted to the CP for processing, there is a three-part code attached to it. The three parts of this code are the Performing Department, the Resource Code and the Cost Code. The performing department code links up the resources to their control organization viz operating Divisions, the resource code identifies each resource (researchers, instruments), and the cost code defines the cost categories of research as well as the elemental costs of each project. This rate-ID is an integral part of each data card which is used to input project cost information. A specimen rate-ID entry on any cost data card is shown in Figure 18.

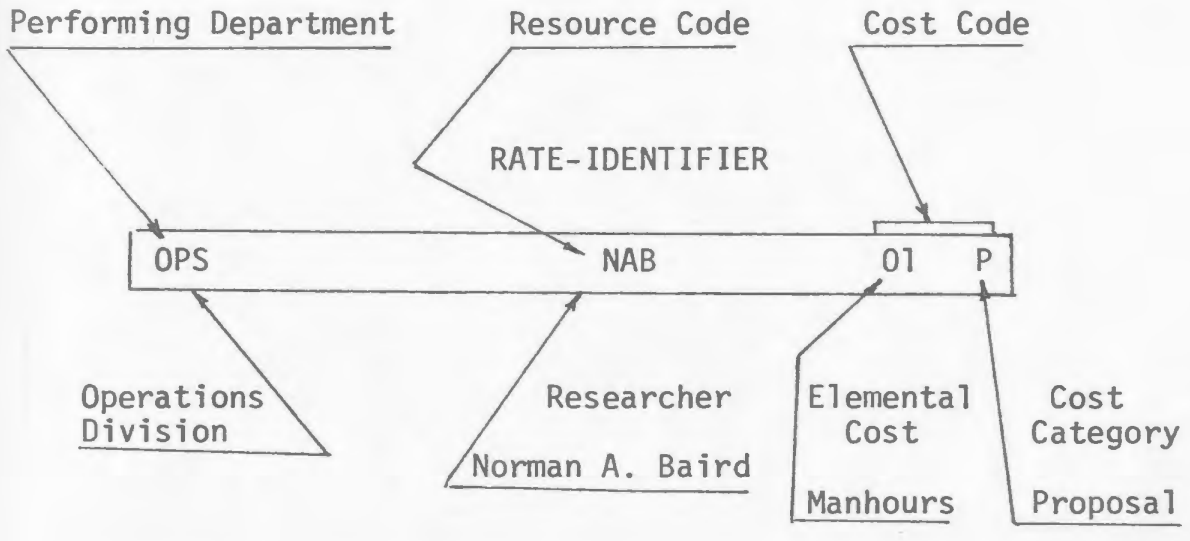


Figure 18: Rate-Identifier Showing Performing Department, Resource Code and Cost Code

Rate Table (RT)

Rate Table contains the chargeout rates of researchers, the rental rates for instruments, Company overheads and burden rates and any adjustment factors to be used for manpower and material classification under each performing department. During the cost calculations by the Cost Processor, appropriate rates as defined for each accounting period are linked up to arrive at the total dollars.

3.1.2 Data Cards

To feed project information to the PMS IV package, there are 82 different types of data cards. These cards for NP define, describe and construct the project schedules; for CP, they specify how costs are to be analyzed; and for the RAP, they define the resource requirement for each project activity and the resource level within the Company. For processing the project information for NORDCO research, only eight of these cards have been used. These are listed below:

Card Type	Description
15	Subnet description (title)
30	Network schedule
61	Work Breakdown Schedule
62	Organization Analysis Table
63	Cost Analysis Table
64	Rainbow Categories (Elemental Costs)
66	Rate Table
70	Network based cost data

A sample of data cards listing using the above types of cards for processing of NORDCO project information is shown in Appendix E. A sche-

matic model showing the interrelationship of information supplied through different cards to process project information is shown in Appendix F.

This concludes description of the program.

3.2 Difficulties in Using PMS IV in its Standard Form

Projects and proposals in the Company have defined start and completion dates within the framework of the accounting period. While new projects are being added regularly during this period, some current ongoing research is completed, cancelled or postponed. There are a number of ongoing research activities which are carried over from the past accounting period to the current accounting period while some of the research of the present period is carried over to the next period. Often research involving an interchange of researchers and instrumentation is linked to research activities within the Company. To interrelate such research into a total NORDCO project schedule, it is possible to use either one of the two possible network designs namely, 'stand-alone' or 'interfaced' networks. In stand-alone design, each project is treated as a separate entity where any change in its schedule having no effect on the schedules of other projects. In an interfaced network, even though each project is treated as a separate entity, there is a commonality of nodes between the various projects. Any change in the schedule of a project adjusts the schedules of all other dependent projects using techniques of forward and backward pass calculations. In the overall context, the NORDCO research can best be described using a totally interfaced network system.

Developing a fully interfaced network for the entire research program of NORDCO poses serious problems of implementation. The project managers being unfamiliar with the activities of the projects outside their area of responsibility, resist the discipline imposed by the schedules generated from interfaced networks. From practical considerations, it is necessary, therefore, to use the stand-alone network design in the multi-project situation of NORDCO.

The activity descriptions of all research projects are generally similar, eg. Field Work, Data Analysis, Report Writing, etc. These activity descriptions pose no difficulty of association when seen under their respective project titles, but cause problems of association when merged for the combined analysis of several projects. This is particularly so when developing the combined cash flow analysis of several projects for management use. To avoid this problem, it is necessary to develop activity description codes which would facilitate identification of activities for each project of the Company in multi-project analyses.

In the area of cost, the chargeout rates of all resources are defined on the Rate Table. The rates are defined for combinations of performing departments, resource codes and cost codes. When the resource of one performing department is employed on a project under another performing department, the Rate-ID for the resource changes with this change in the performing department code. This can be seen by a reference to Figure 18 (Rate-Identifier). If the performing department code of resource NAB is changed from 'OPS', representing Operations Division, to say 'RSH',

representing Oceanographic Research Division, a new Rate-ID is obtained for the same resource NAB to cover its costs under its new performing department. This built-in design consideration of the Cost Processor necessitates using three Rate-IDs for the same resource to cover its employment under the three different performing departments of the Company. But the chargeout rates of researchers and the rental rates of instruments remain constant irrespective of the Division employing the resource. This is uneconomical with respect to data input and processing costs.

In a similar way, the performing department codes affect the Rate-ID and thereby increase the number of RT cards, the change of cost codes for defining the four cost categories of NORDCO research under each performing department increase the number of RT cards for each resource. In the NORDCO situation, to cover the variations of performing departments and cost codes, 12 different RT cards are required for every single resource of the Company. This again is uneconomical with respect to data input and processing costs.

Considering the capabilities of the PMS IV computer package and the difficulties of its use for NORDCO research, a project management model for the Company has been developed using a modified PMS system. This model is explained in the following section.

3.3 Project Management Model for NORDCO

The Project Management Model for NORDCO is based on the built-in design of the Network Processor and the Cost Processor. Project information into

these modules is selected, processed, supressed, sorted, formated, scaled and paged using one or several of the 22 control subroutines of the Report Processor. The design and adaptations of NORDCO model has been done in a manner that facilitates data identification, data processing and data control to obtain suitable information reports for the various management levels. The details of the modifications and adaptations of this model for NORDCO are described in two parts. The first part deals with the Network Processor design and adaptations and the second part deals with the changes pertaining to the Cost Processor.

Network Processor

Every project processed in the NP is identified by a 'subnet name'. To describe this name, the NP has a five character field width. One of the control subroutines of the RP selects, segregates and processes the subnets based on a selection of any of the five characters contained in this subnet field.

The project account number allotted for NORDCO research projects are described as '13-78', representing the thirteenth project of the year 1978. This account number has been selected to define the project subnet name. Further, the four cost categories of research projects have been assigned cost codes, eg. 'P' for Proposals; 'I' for Industry Projects; 'N' for In-House Projects; and 'G' for Government Projects. To accommodate the project account number as well as the cost category of each project within the limits of the available five character field of the subnet, project subnet name is designed as '1378N'. The first four

characters of this subnet name describe the project account number, ie. 13-78. The fifth character 'N' identifies the cost category of the project, ie. In-House Project. By this design, it is possible to focus a control subroutine of the RP on the fifth character of the subnet name to segregate and process NORDCO research by the desired cost categories.

A subnet of a project represents a chain of mutually interdependent activities. These activity chains are defined by their start and end nodes which have progressive serial numbers. When a large number of project subnets are processed together, there is a repetition of the serial numbers of the subnet nodes. This point is explained by an example of three subnet activity chains as shown below in Figure 19.

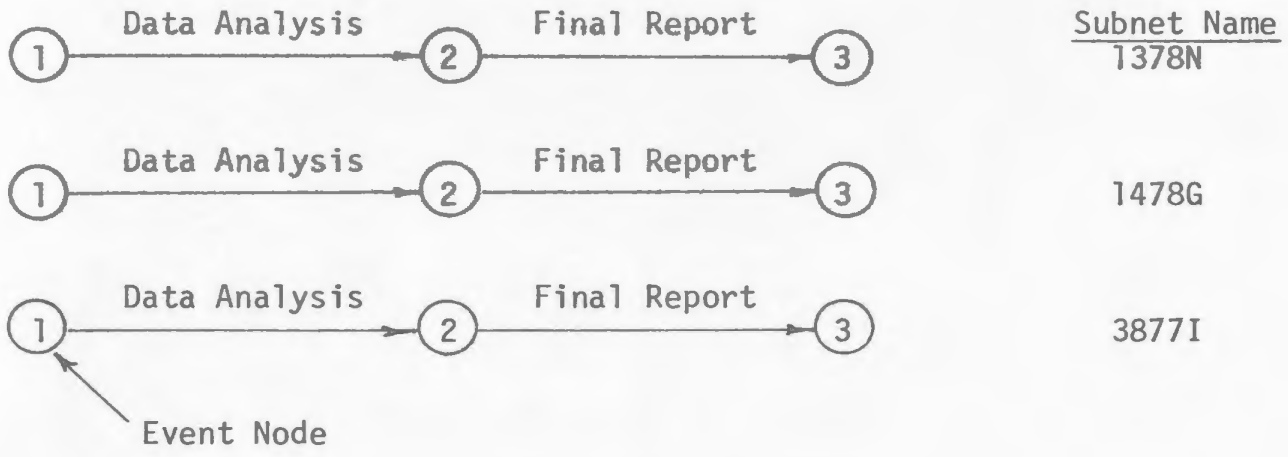


Figure 19: Event Node Design of Project Schedules

In these three subnet event nodes, there is a repetition of event nodes '1s', '2s', '3s' making it difficult to link similar project activities to their respective subnets.

To overcome this problem in identifying event nodes of different subnets, a five character numeric code has been designed to correspond to the built-in numeric field for the event node in the NP. This event node design has a composite number containing the information of its subnet and its node serial number. This design is shown below in Figure 20.

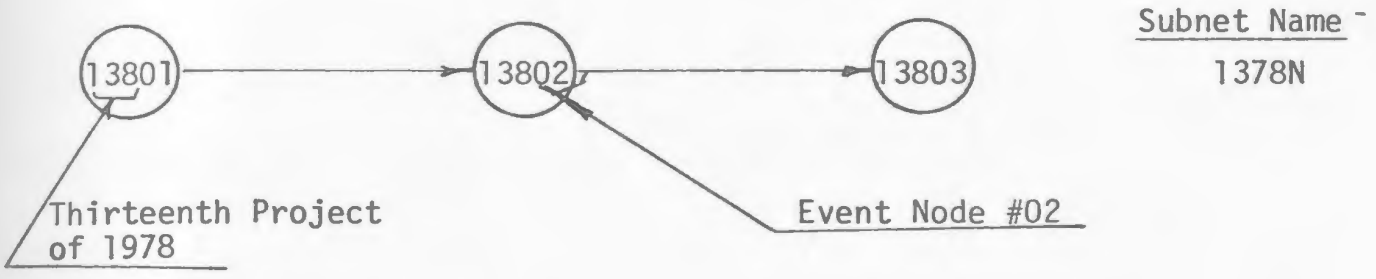


Figure 20: Event Nodes Design for NORDCO Project Schedules

The first three characters, ie. '138' represent the project account number '13-78'. The calendar year is defined by its rightmost digit. In this example 1978 is represented by digit '8'. This does not cause any confusion as no research project is likely to exceed ten years of research effort. Projects of 1979 and 1980 can be defined as '139' and '130', respectively. The last two characters of the event node field, ie. '01', '02', '03' identify the serial number of the event node for their respective subnets. This design helps to identify the event nodes when processing several subnets simultaneously.

The network design of NORDCO research lends itself to the use of 'stand alone' networks. In this design, individual projects (subnets) can be added or taken out whenever required without causing any serious

problem to the Company schedule. In this design, each subnet is a separate cost entity and generates its own schedule.

To understand the effect of the computer processing time when using network designs based on 'stand-alone' subnets and 'interfaced' networks, two sets of Company network schedules using the same 74 subnets were processed separately for each of the two designs. The comparison of the processing times is shown in Appendix G. It is observed that no additional cost is involved in 'stand-alone' processing which is adopted in the Company.

Cost Processor

Project costs to be processed by the CP are identified through the Rate-ID. This Rate-ID has a five character field each for the performing department, resource code and cost code. The chargeout rates of the resources are defined on the Rate Table. In developing project costs the usage hours of the resources (researchers and instruments) need conversion to dollars using their chargeout rates contained in the RT. Other costs, such as travel, consultants' fees, subcontracts, and so on, are input as direct costs needing no conversion. For the resources to pick up their appropriate chargeout rates, a three character resource code has been designed to specify each researcher by his initials and his type of employment viz in office or in field. This distinction is necessary as the chargeout rate for office work and field work are differently specified in the RT. Instruments too have a three character resource code where the first letter is always 'E' indicating it to be an item of instrument

and the next two characters are its serial number as per the Company list of instruments. No distinction for their employment in office or field is necessary as their rates under these types of usage are the same. Examples of the resource codes for researchers and instruments are shown below:

Resource Code	Meaning
NBO	Norman Baird: Office Work
WBF	William Buschman: Field Work
E01	Equipment Serial 01: Sea Trak Current Meter.

The cost codes identify the cost categories and the elemental costs within these categories. The cost categories are Proposals, Industry, In-House and Government Projects and the eight elemental costs are the same as indicated in Figure 17. The resource and cost codes designed with these considerations are explained by the example below:

Resource Code	Cost Code		Explanation of the Cost Code
NBO	01ØØP	01	elemental cost (manhours)
		P	cost category (proposal)
NBF	01ØØI	01	elemental cost (manhours)
		I	cost category (Industry Project)
E01	04ØØN	04	elemental cost (NORDCO instrument rental)
		N	In-house project
E87	04ØØG	04	elemental cost (NORDCO instrument rental)
		G	Government project

In the charge number (activity) field, consideration has been given to standardize the charge number description. Cost Processor allows for an 18 character field length to describe these charge numbers. For ease of activity identification, each charge number field is utilized as under:

Field	Cost Element
1 & 2	Cost Element
3	Blank
4 - 8	Project Number
9 - 18	Activity Description

This charge number description provides ease of reference during analysis even when cost data for a large number of projects is processed together.

The costs of all research activities are broken down under eight elemental costs and these are assigned distinct codes. Each activity has been prefixed with one of these codes. Specimen input data cards for activities involving input of researchers, a consultant, NORDCO instruments, outside rental instruments, and travel are shown in Figure 21.

Columns 24 to 41 (18 characters) define the charge number and by defining cost elements (01, 05, etc) as part of the charge number, it is possible to segregate these costs by using the control cards of the Report Processor. This separation of costs into elemental costs is very useful in making financial cost analyses of the Company.

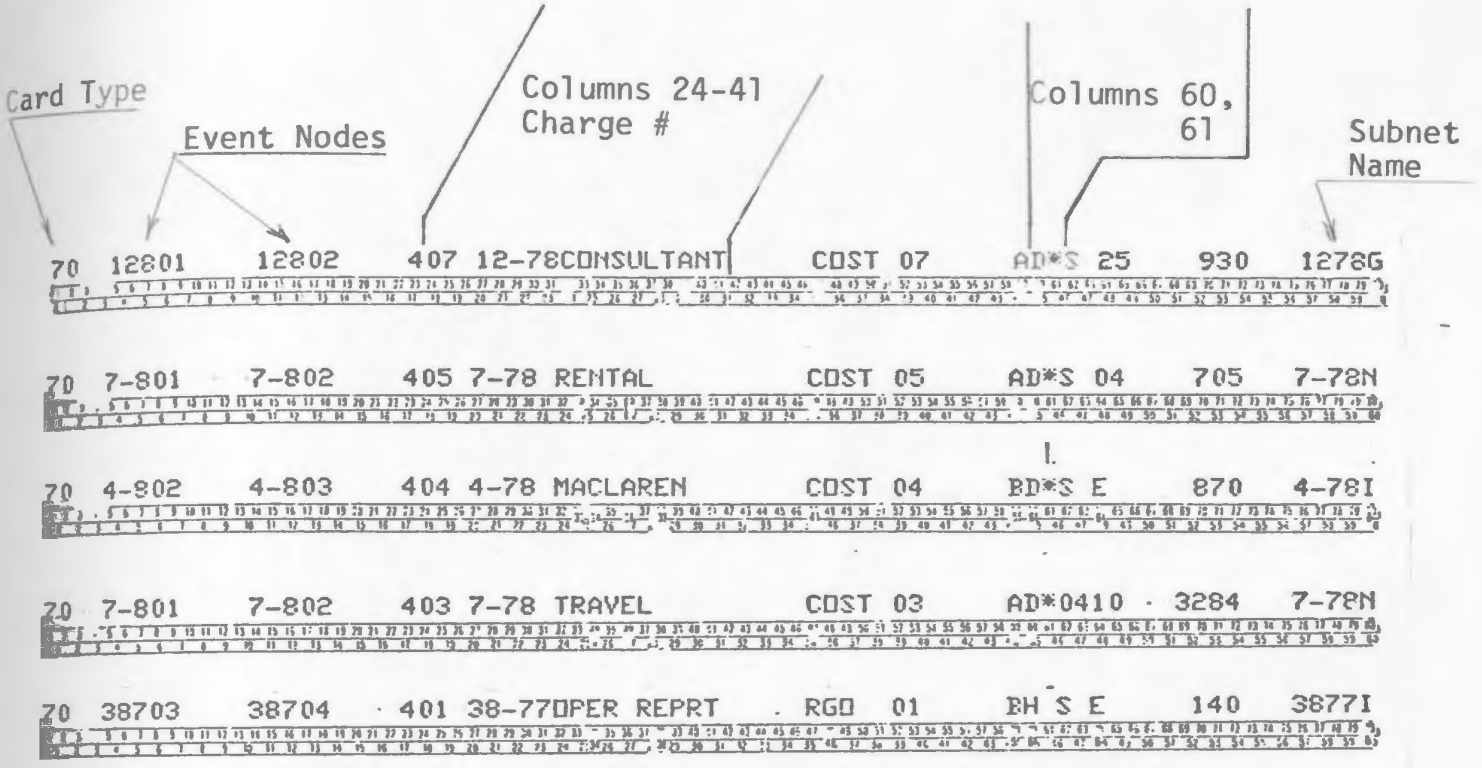


Figure 21: Card Type 70 - Data Input Cards (CP)

The use of columns 60 and 61 of cards type 70 is an important factor in deciding how costs are to be summed up for management information. There are six possibilities available for input in column 60 and four in column 61 allowing for a total possible combination of 24 to process the cost data. For NORDCO design, only two codes are used in column 60 and two in column 61. In column 60, code 'H' defines hours and 'D' defines the direct costs. Hours are entered for researchers time used on their projects and these hours are extended to dollars by applying appropriate

rates from the Rate Table. All costs other than manhours are associated with code 'D'. Being direct costs, no extension via Rate Table is necessary.

Two codes signified by '*' or 'BLANK' are used in column 61. 'H' with a 'BLANK' indicates that the cost is to be converted to direct money at the unit rate and extended at the burden rate. 'D' with an '*' indicates that the cost field is neither to be extended nor to be added to total money. This combination ensures that all costs (direct and converted) are reflected in individual project costs reports but direct costs are not included in the Management Summary Reports. Thus a cost such as Ship Charter, which is directly paid by the client or any subcontract cost which is not under management control is reflected in individual project cost reports but is not included in the Management Summary Reports. This helps management to concentrate on costs which are amenable to its control.

PMS IV when used in control of construction projects where work is generally performed by means of many subcontractors having different rates for tradesmen, accommodates this variation by associating a rate with each combination of performing department and a resource code. In NORDCO, there is no such rate differential for staff when working in different Divisions of the Company. Thus, there is no need to vary rates of any resource with any change of its performing department. Use of Rate-ID in the project management model for NORDCO without specifying any performing department has resulted in a saving of 2,160 RT cards thereby reducing the

data processing costs. An explanation of this saving is provided in Table 2.

TABLE 2

SAVINGS IN RATE TABLE CARDS

Number of Operating Divisions - 3
Number of Researchers - 60
Number of Instruments - 100
Cost Categories applicable to each researcher - 4
Cost Categories applicable to each instrument - 3

Description	PMS IV Design		Modified Design	
	Staff	Instruments	Staff	Instruments
Strength	60	100	60	100
RT Cards for budgeted rates	60	100	60	100
RT Cards for actual rates	60	100	60	100
Cost Categories	4	3	4	3
Performing Departments	3	3	0	0
TOTAL Rate Table Cards	1,440	1,800	480	600
	= 3,240		= 1,080	

SAVING IN RT CARDS 3,240 - 1,080 = 2,160 RT Cards

Taking into consideration all the modifications and adaptations explained in the foregoing paragraphs, a cost flow model meeting NORDCO's management information requirements is shown in Appendix H. This cost flow model is dependent upon the WBS, CAT, OAT and the project information collected through data cards and forms the basis of all management information reporting for NORDCO.

In preparations of the information reports, the control subroutines of the Report Processor have been selectively used.

CHAPTER IV

CONCLUSIONS

CHAPTER IV

4.0 CONCLUSIONS

A Management Information System (MIS) for NORDCO has been designed, tested and introduced to control ocean research projects, and to help the Company management in making appropriate policy decisions. This MIS is based heavily on existing computer program Project Management System IV - (PMS IV: IBM). The flexibility of this general purpose program has been innovatively used to process research project information and to obtain suitable management information reports.

In introducing the MIS in NORDCO, several problems had to be surmounted. The major problems were as follows:

Firstly, there was an incompatibility of the existing accounting system of the Company with the computerized MIS. The input of project cost data from the manual accounting system always lagged behind the cut off date for data input to the MIS. This resulted in delayed and somewhat inaccurate management information reports. To overcome this problem, the Company is now setting up a computerized accounting system. This system will be integrated with the MIS so that the project cost data input to MIS is accurate, up-to-date and in time.

Secondly, there was no central co-ordinating agency to supply the required project information for the MIS. The information on all the ongoing projects had to be gathered individually from the project managers concerned. This resulted in a considerable loss of time. To overcome this difficulty, the allotment of the project account number to all projects

has been centralized. This ensures that the projects even though planned and approved in the different Divisions of the Company are co-ordinated under one central agency.

Thirdly, there was a lack of standard costing codes as the existing manual accounting system did not necessitate their use. A system of cost categories and cost elements has been introduced to process project cost information adequately.

Fourthly, there was no suitable data for a break even analysis. A system of information reports has been set up which will provide the necessary information for the break even analysis at a later date.

Besides these problems, there was a lack of sufficient mutual awareness among the staff about the ongoing research activities in different projects of the Company. To provide this awareness, information channels have been designed and set up to disseminate project information to different echelons of the Company management. This has resulted in better human resource utilization and a greater research awareness.

The management information reports (Appendices D1-D10) have been obtained through sustained developmental efforts. This system is now in use for control of NORDCO research and will improve progressively based on the experience gained. The real benefits of such an effort will only be known after it has been in operation for a sufficient period of time.

APPENDIX A

BIBLIOGRAPHY

1. Ahuja, H.N. Construction Performance Control Through Networks, Wiley Inter-Science, New York, 1975.

2. Archibald, R.D. Managing High Technology Program & Projects, John Wiley & Sons, New York, 1976.

3. Elmore, R.L., Sullivan, D.C., Project Control Through Work Packaging Concepts, Arthus Anderson Chronicle, Volume 35, No. 3, p. 60, 1975.

4. Glew, C.E., Project Control Through Work Packaging, PMI Congress Proceedings, Chicago, Illinois, October 22-26, 1977.

5. Hart, H. Overhead Costs: Analysis and Control, Heinemann, London, England, 1973.

6. Hollenback, F.A., Schultz, D.P. The Organization and Control of Project Management, PMI Proceedings, Chicago, Illinois, USA, October 22-26, 1977.

7. IBM, Project Management System IV (PMS IV) Network Processor Program Description and Operations Manual, IBM Corporation, New York, Revised Edition, 1975.

8. IBM, Project Management System IV (PMS IV) Cost Processor Program Description and Operations Manual, IBM Corporation, New York, Revised Edition, 1975.

9. IBM, Project Management System IV (PMS IV) Report Processor Program Description and Operations Manual, IBM Corporation, New York, Revised Edition, 1975.

10. Piepgrass, E.B., Lobley, T., Project Control for Projects too Small for Project Control, PMI Proceedings, Chicago, Illinois, October 22-26, 1977.

11. Pilcher, Roy Appraisal and Control of Project Costs, McGraw Hill, London, England, 1973.

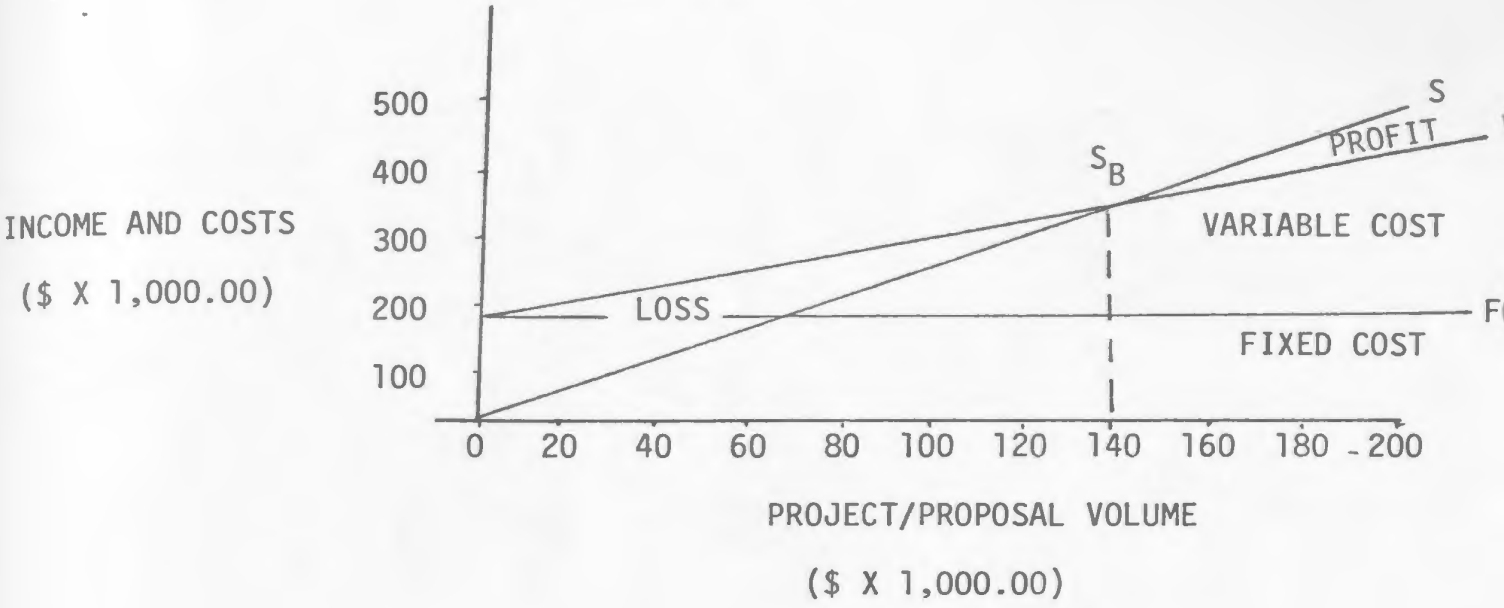
12. Sloat, F.W., Project Planning as a Means to Team Building Integration and Motivation, PMI Proceedings, Chicago, Illinois, p. 398, October 22-26, 1977.

13. Weston, J.F., Brigham, E.F. Managerial Finance, The Dryden Press, Hinsdale, Illinois, USA, 1975.

14. Wilson, R.M.S. Cost Control Handbook, Halsted Press, New York, p. 357, (1975).

APPENDIX A

BREAK EVEN ANALYSIS



At the Break-Even Point, dollar value of all categories of research projects (S_B) is equal to fixed costs (FC) plus variable costs (VC).

$$S_B = FC + VC \text{ ---------- (i)}$$

At the Break-Even Point, both the invoiced dollar value of ocean research projects and variable cost per unit are assumed constant, thus the ratio $\frac{VC}{S}$ for <u>any</u> given level of invoicing is also constant and may be found from the annual income statement.

Since variable cost is a constant percentage of the invoiced value, the equation (i) can be written as:

$$S_B = FC + \frac{VC}{S}(S_B)$$

$$FC = S_B\left(1 - \frac{VC}{S}\right)$$

$$S_B = \frac{FC}{1 - \frac{VC}{S}}$$

where: S_B = Project Volume at Break-Even

FC = Total Fixed Costs

VC = Total Variable Costs

S = Current and Anticipated Project Volume.

Example on next page.

Relations among Unit Solds, Total Variable Costs, Fixed Costs, Total Costs, and Total Income

A. Trial-and-error Calculations

Units Sold	Total variable Cost	Fixed Cost	Total Costs	Sales	Net Profit (loss)
20,000	$24,000	$40,000	$64,000	$40,000	$ (24,000)
40,000	48,000	40,000	88,000	80,000	(8,000)
50,000	60,000	40,000	100,000	100,000	--
60,000	72,000	40,000	112,000	120,000	8,000
80,000	96,000	40,000	136,000	160,000	24,000
100,000	120,000	40,000	160,000	200,000	40,000
120,000	144,000	40,000	184,000	240,000	56,000
140,000	168,000	40,000	208,000	280,000	72,000

B. Algebraic Solution to Break-even Point

1. The break-even quantity is defined as the volume of output at which revenue is just equal to total costs (fixed costs plus variable costs).

2. Let:

   P = Sales price per unit

   Q = Quantity produced and sold

   F = Fixed costs

   V = Variable costs per unit

3. Then:

$$P \times Q = F + V \times Q$$

$$P \times Q - V \times Q = F$$

$$Q(P - V) = F$$

$$Q = \frac{F}{P - V} \text{ at break-even Q.}$$

4. Illustration:

$$Q = \frac{\$40,000}{\$2.00 - \$1.20}$$

$$= 50,000 \text{ units}$$

Calculation of Break-even Point Based on Dollar Sales

$$\text{Break-even point} = \frac{\text{total fixed costs}}{1 - \frac{\text{total variable costs}}{\text{total sales volume}}} = \frac{FC}{1 - \frac{VC}{S}}$$

Procedure

Take any sales level and use the related data to determine the break-even point. For example, assume that 20,000 units were actually produced and sold, and use the data related to that output in Table 3-2:

$$\text{Break-even Point} = \frac{\$40,000}{1 - \frac{\$24,000}{\$40,000}} = \frac{\$40,000}{0.4} = \$100,000$$

Rationale

1. At the break-even point, sales (S_B) are equal to fixed cost (FC) plus variable cost (VC): $S_B = FC + VC$.
2. Because both the sales price and the variable cost per unit are assumed to be constant in break-even analysis, the ratio VC/S for any level of sales is also constant and may be found from the annual income statement.
3. Since variable cost is a constant percentage of sales, equation 3-1 can be written as:

$$S_B = FC + \frac{VC}{S}(S_B)$$

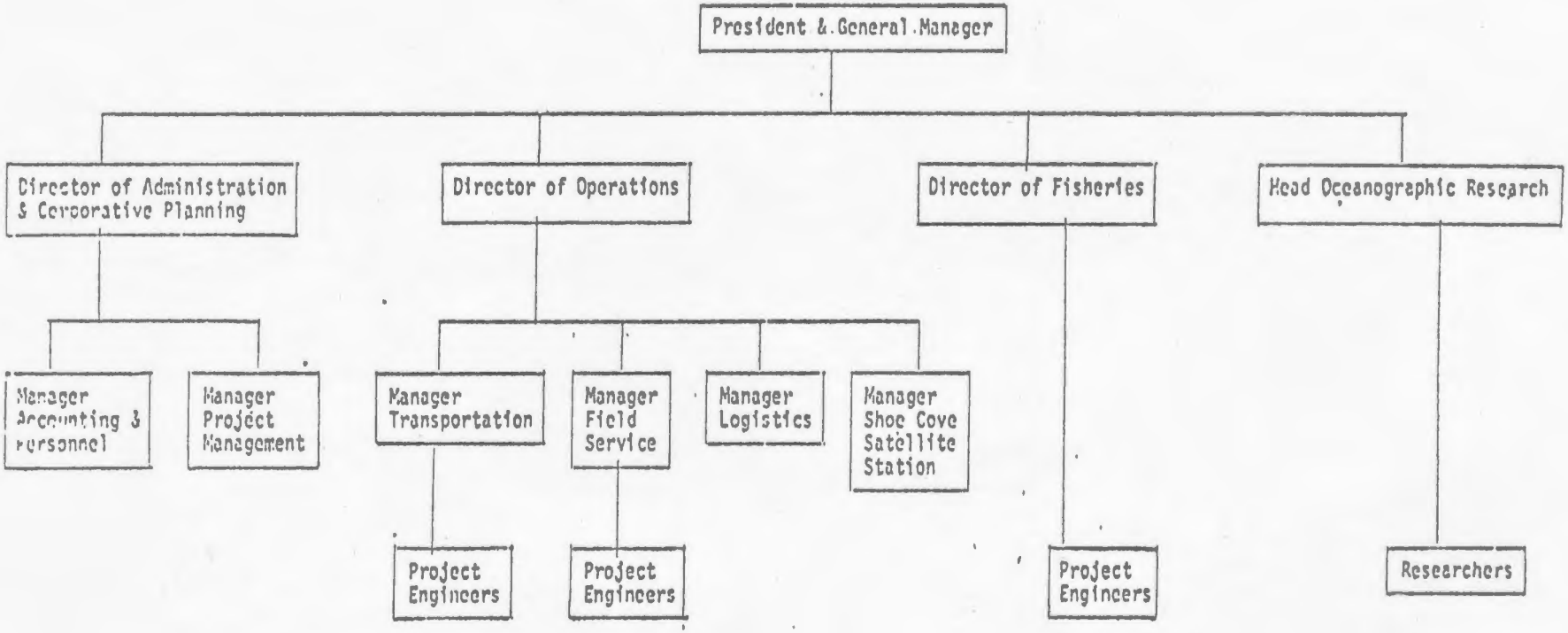
$$S_B\left(1 - \frac{VC}{S}\right) = FC$$

$$S_B = \frac{FC}{1 - \frac{VC}{S}} \text{ at break-even S.}$$

APPENDIX B

ORGANIZATIONAL SETUP OF NORDCO LIMITED

1978



APPENDIX C

APPENDIX C

IN THE MINDS OF / QUESTIONS	PRES	DIR OPR	DIR ADMIN	PJR MGR	MGR ACCT	MGR LOG
SCHEDULE						
1. Is the work progress on company projects/ proposals on schedule?		✓	✓	✓		
2. Are the consultants/ subcontractors meeting their schedules?		✓		✓		
3. Is material & instrumentation availabilty according to schedule?		✓	✓	✓		✓
4. Are project contracts being submitted according to plan?	✓	✓	✓	✓		
RESOURCES						
1. Are manhours expended within the estimates?		✓		✓		
2. Is the work so planned that work will not stop due to shortage of resources?		✓		✓		✓
BUDGET						
1. Does the bid price include provision for contingencies, escalation, overhead and mark up?		✓	✓			
2. Is there any provision in the contract for change order/revision of estimates?		✓	✓			
3. Is the project cost after revision & redesign within the original estimate?		✓	✓			
4. Are research design and project execution costs as per estimates?		✓		✓		
5. What is the deviation of actual cost from the estimated cost?		✓		✓		

IN THE MINDS OF QUESTIONS	PRES	DIR OPR	DIR ADMIN	PJR MGR	MGR ACCT	MGR LOG
6. What is the net cost of the project and how does it compare with its budgeted cost?	✓	✓	✓		✓	
7. Are material wastages and instrument losses within reasonable limits?		✓	✓			✓
8. Is equipment & instrumentation fully utilized?	✓	✓	✓			
9. Is each piece of equipment & instrumentation economical?	✓	✓	✓			
10. Will the project/proposal be completed within its cost target?		✓		✓		
11. Is the overhead cost as per plan?		✓	✓			
12. Does the trend show overrun or under run?		✓		✓		
CASH FLOW						
1. What is the cash flow forecast?	✓	✓	✓			
2. Do the budgets conform with the cash flow forecast?	✓	✓	✓			
3. Are the financing costs kept to the minimum?	✓		✓			
4. Are the invoices being sent in time?			✓		✓	
5. What is the break-even point at the planned level of work?	✓		✓			

APPENDICES D1-D10

WORK PLAN REPORT

PAGE 3

PROGRAM
PROJECT 01APR77 ICEBERG SCOURING GH INHS PJT OPERATIONS DIV

PROJECT 2876N

RUN DATE 17AJG78

LEVEL DETAIL

SORTED BY

PRED. EVENT	SUCC. EVENT	CYCLE CODE	ACTIVITY DESCRIPTION	DURATION	FLOAT TOTAL	FLOAT FREE	START DATES EXPECTED	START DATES LATEST	COMPLETION DATES EXPECTED	COMPLETION DATES LATEST	SCHED DATE
	29601	S	START OF PROJECT	0.00	.0	.0	A01APR77	01APR77	A01APR77	01APR77	
28601	29602		PRIOR WORK	365.00	.0	.0	A01APR77	01APR77	01APR78	01APR78	
29602	29603		PRESENT WORK	365.00	.0	.0	01APR78	01APR78	01APR79	01APR79	
29603		E	END OF PROJECT	0.00	.0	.0	01APR79	01APR79	01APR79	01APR79	

WORK PLAN REPORT

PAGE 4

PROGRAM
PROJECT 31MAY78 HARBOUR GRACE FISH LANDING FACILITY NB GOVT PJT OPS

PROJECT 4478G

RUN DATE 17AJG78

LEVEL DETAIL

SORTED BY

PRED. EVENT	SUCC. EVENT	CYCLE CODE	ACTIVITY DESCRIPTION	DURATION	FLOAT TOTAL	FLOAT FREE	START DATES EXPECTED	START DATES LATEST	COMPLETION DATES EXPECTED	COMPLETION DATES LATEST	SCHED DATE
	44901	S	START OF PROJECT	0.00	.0	.0	A31MAY78	31MAY78	A31MAY78	31MAY78	
44901	44902		PROJECT ACTIVITY	46.00	.0	.0	A31MAY78	31MAY78	16JUL78	16JUL78	
44902		E	END OF PROJECT	0.00	.0	.0	16JUL78	16JUL78	16JUL78	16JUL78	

PROGRAM-IDENTIFICATION= 2876N
PROGRAM-DESCRIPTION= 01APR77 ICEBRG SCOURING GH INHS PJT OPERATIONS DIV . 2876N

CONTRACT DESCRIPTION	REPORTING ORGN	CONTRACT NO.	REPORT DATES
	RUPINDER RANGAR		TERM (SPAN)= 01APR77 ONWARDS
			CUT OFF DATE= 31AUG78
LEVEL/SUMMARY ITEM= 1/		NORDCO RESEARCH	RELEASE DATE= 18AUG78

IDENTIFICATION	MANHOURS					TOTAL COST $/1				
	TO DATE		TOTALS AT COMPLETION			WORK TO DATE		TOTALS AT COMPLETION		
COST CATEGORY	PLANNED	ACTUAL	PLANNED	LATEST REVISED ESTIMATE	PROJECTED (OVERRUN) UNDERRUN	PLANNED	ACTUAL	PLANNED	LATEST REVISED EST	PROJECTED (OVERRUN) UNDERRUN
	0	0	0	0	0	0	5,131	0	5,131	(5,131)
IN-HOUSE PROJECTS	154	9	378	9	0.98 369	17,040	4,634	45,207	4,634	0.90 40,573
TOTAL						17,040	9,765	45,207	9,765	35,442

PROGRAM-IDENTIFICATION= 2876N
PROGRAM-DESCRIPTION= 01APR77 ICEBERG SCALING GH INHS PJT OPERATIONS DIV 2876N

CONTRACT DESCRIPTION	REPORTING ORGN	CONTRACT NO.	REPORT DATES
PUP INDER RANGAR			TERM (SPAN)= 01APR77 ONWARDS
			CUT OFF DATE= 01AUG78
LEVEL/SUMMARY ITEM= 1/		NORDCO RESEARCH	RELEASE DATE= 18AUG78

IDENTIFICATION	MANHOURS					TOTAL COST $/1				
	TO DATE		TOTALS AT COMPLETION			WORK TO DATE	TOTALS AT COMPLETION			
RAINBOW CATEGORY	PLANNED	ACTUAL	PLANNED	LATEST REVISED ESTIMATE	PROJECTED (OVERRUN) UNDERRUN	PLANNED	ACTUAL	PLANNED	LATEST REVISED EST	PROJECTED (OVERRUN) UNDERRUN
	112	0	336	0	1.00 336	3,760	0	11,281	0	1.00 11,281
CONSULTANT	0	0	0	0	0	3,674	0	11,000	0	1.00 11,000
INSTRUMENT RENTAL OTHERS	0	0	0	0	0	0	2,422	0	2,422	(2,422)
MANPOWER COSTS	42	9	42	9	0.79 33	2,926	389	2,926	389	0.87 2,537
MATERIALS	0	0	0	0	0	6,680	0	20,000	0	1.00 20,000
PRIOR MANPOWER	0	0	0	0	0	0	4,298	0	4,298	(4,298)
PRIOR OTHER COSTS	0	0	0	0	0	0	833	0	833	(833)
TRAVEL	0	0	0	0	0	0	1,823	0	1,823	(1,823)
TOTAL						17,040	9,765	45,207	9,765	35,442

ORGANIZATION STATUS REPORT
BY RESP ORGN, CHARGE, PERF ORGN, RES CODE

PROGRAM-IDENTIFICATION= 2876N
PROGRAM-DESCRIPTION= 01APR77 ICEBERG SCOURING GH INHS PJT OPERATIONS DIV 2876N

CONTRACT DESCRIPTION	REPORTING ORGN.	CONTRACT NO.	REPORT DATES
	RUPINDER RANGAR		TERM (SPAN)= 01APR77 ONWARDS
			CUT OFF DATE= 01AUG78
LEVEL/SUMMARY ITEM= 3/		28-76N	RELEASE DATE= 18AUG78

IDENTIFICATION				MANHOURS				DIRECT COSTS $/ 1				TIME	
				WORK TO DATE	TOTALS AT COMPLETION			WORK TO DATE	TOTALS AT COMPLETION				
CHARGE NUMBER	RESP ORGN	PERF ORGN	RES CODE	ACTUAL	PLANNED	LATEST REVISED ESTIMATE	PROJECTED (OVERRUN) UNDERRUN	ACTUAL	PLANNED	LATEST REVISED ESTIMATE	PROJECTED (OVERRUN) UNDERRUN	MOST CRIT SLACK (WKS)	SCHED OR ACT (A) COMPL DATE
	OPERAN												
01 28-76 PJT WORK		BMSO		6	0	6	(6)	180	0	180	(180)		
		DRO		3	42	3	39	209	2,926	209	2,717		
		TKO		0	336	0	336	0	11,281	0	11,281		
							0.98				0.97	.0	
TOTAL				9	378	9	369	389	14,207	389	13,818		
01 28-76 PRIOR		COST		0	0	0	0	4,298	0	4,298	(4,298)		
												.0	
TOTAL				0	0	0	0	4,298	0	4,298	(4,298)		
02 28-76 PRIOR		COST		0	0	0	0	833	0	833	(833)		
												.0	
TOTAL				0	0	0	0	833	0	833	(833)		
02 28-76MATERIALS		COST		0	0	0	0	0	20,000	0	20,000		
											1.00	.0	
TOTAL				0	0	0	0	0	20,000	0	20,000		
03 28-76TRAVEL		COST		0	0	0	0	1,823	3,000	1,823	1,177		
											0.39	.0	
TOTAL				0	0	0	0	1,823	3,000	1,823	1,177		

ORGANIZATION STATUS REPORT
BY RESP ORGN,CHARGE,PERF ORGN,RES CODE

PAGE 6

PROGRAM-IDENTIFICATION- 2876N
PROGRAM-DESCRIPTION- 01APR77 ICEBERG SCOLRING GH INHS PJT OPERATIONS DIV 2876N

CONTRACT DESCRIPTION	REPORTING ORGN	CONTRACT NO	REPORT DATES
	RUPINDER PANGAR		TERM (SPAN)- 01APR77 ONWARDS
			CUT OFF DATE- 01AUG78
LEVEL/SUMMARY ITEM- 3/		2876N	RELEASE DATE- 18AUG78

IDENTIFICATION				MANHOURS				DIRECT COSTS $/ 1				TIME	
				WORK TO DATE	TOTALS AT COMPLETION			WORK TO DATE	TOTALS AT COMPLETION				
					LATEST ESTIMATE	PROJECTED REVISED	(OVERRUN) UNDERRUN		LATEST ESTIMATE	PROJECTED REVISED	(OVERRUN) UNDERRUN	MOST CRIT (WKS)	SCHED OR ACT (A) COMPL DATE
CHARGE NUMBER	RESP ORGN	PERF ORGN	RES CODE	ACTUAL	PLANNED			ACTUAL	PLANNED			SLACK	
OPERAN													
05 2876INSTR CNTL			COST	0	0	0	0	2,422	3,986	2,422	1,564		
											0.39	.0	
TOTAL				0	0	0	0	2,422	3,986	2,422	1,564		
07 2876 DE EAD			COST	0	0	0	0	0	11,000	0	11,000		
											1.00	.0	
TOTAL				0	0	0	0	0	11,000	0	11,000		
							0.98				0.81		
TOTAL				5	378	9	369	9,765	52,193	9,765	42,428		

ORGANIZATION STATUS REPORT
BY OAT,DEPARTMENT,CHARGE

CONTRACT DESCRIPTION | REPORTING ORGN. | CONTRACT NO. | REPORT DATES

RUPINDER RANGAR | TERM (SPAN)= 01APR77 ON&ADS
CUT OFF DATE= 01AUG78
LEVEL/SUMMARY DEPT= 1/ | RELEASE DATE= 15AUG78

IDENTIFICATION				MANHOURS				DIRECT COSTS $/ 1				TIME	
				TO-DATE	TOTALS AT COMPLETION			TO-DATE	TOTALS AT COMPLETION				
						LATEST REVISED EST	PROJECTED OVERRUN UNDERRUN			LATEST REVISED EST	PROJECTED OVERRUN UNDERRUN	MOST CRIT SLACK	SCHED OR ACT (A) COMPL DATE
CHARGE NUMBER & LEVEL 3	RESP ORGN	PERF DEPT	RES CODE	ACTUAL	PLANNED			ACTUAL	PLANNED				
				FORCE LEVEL 2									
				0	0	0	0	1,684	0	1,684	(1,684)		.0
OVHD FISHERIES				0	0	0	0	17,013	0	17,013	(17,013)		.0
52-76N				88	0	88	(88)	11,601	0	11,601	(11,601)		.0
OVHD OPERATIONS				0	0	0	0	20,341	0	20,341	(20,341)		.0
14-78I				124	500	124	376	10,291	11,286	10,291	995		.0
21-77S				41	156	41	115	11,948	5,405	11,948	(6,543)		.0
29-76N				9	378	9	369	9,765	52,193	9,765	42,428		.0
44-78S				49	165	49	116	1,922	10,379	1,922	8,457		.0
OVHD RESEARCH				0	0	0	0	6,222	0	6,222	(6,222)		.0
12-78S				209	4,437	209	4,229	7,943	74,843	7,943	66,900		.0
31-78S				5	53	5	48	171	1,643	171	1,472		.0
33-77I				206	140	206	(66)	22,638	10,400	22,638	(12,238)		.0
							0.87					0.27	
TOTAL				730	5,829	730	5,099	121,539	166,149	121,539	44,610		
							0.87					0.27	
			TOTAL	730	5,829	730	5,099	121,539	166,149	121,539	44,610		

FINANCIAL PLAN AND STATUS
BY MONTH, BY SUMMARY CHARGE

PAGE 3

CONTRACT DESCRIPTION	REPORTING ORGN.	CONTRACT NO.	REPORT DATES
	RUPINDER RANGAR		TERM (SPAN)- 01APR77 ONWARDS
			CUT OFF DATE- 01AUG78
LEVEL/SUMMARY ITEM- 1/		NORDCO RESEARCH	RELEASE DATE- 18AUG78

MONTH	CHARGE NUMBER	INCREMENTAL COST X 1 ACTUAL	INCREMENTAL COST X 1 PLANNED	INCREMENTAL COST X 1 LATEST REVISED EST.	INCREMENTAL COST X 1 (OVER) UNDER PLAN	CUMULATIVE COST X 1 ACTUAL	CUMULATIVE COST X 1 PLANNED	CUMULATIVE COST X 1 LATEST REVISED EST.	CUMULATIVE COST X 1 (OVER) UNDER PLAN	REMARKS
DEC 77	FISHERIES DIV	776	0	776	(776)	6,868	0	6,868	(6,868)	
	TOTAL	776	0	776	(776)	11,999	0	11,999	(11,999)	
JAN 78	FISHERIES DIV	775	0	775	(775)	7,643	0	7,643	(7,643)	
	OPERATIONS DIV	2,634	950	2,634	(1,684)	7,765	950	7,765	(6,815)	
	RESEARCH DIV	8,517	0	8,517	(8,517)	8,517	0	8,517	(8,517)	
	TOTAL	11,926	950	11,926	(10,976)	23,925	950	23,925	(22,975)	
FEB 78	FISHERIES DIV	699	0	699	(699)	8,342	0	8,342	(8,342)	
	OPERATIONS DIV	5,733	3,591	5,733	(2,142)	13,498	4,541	13,498	(8,957)	
	RESEARCH DIV	4,125	885	4,125	(3,240)	12,642	885	12,642	(11,757)	
	TOTAL	10,557	4,476	10,557	(6,081)	34,482	5,426	34,482	(29,056)	
MAR 78	FISHERIES DIV	776	0	776	(776)	9,118	0	9,118	(9,118)	
	OPERATIONS DIV	6,370	3,900	6,370	(2,470)	19,868	8,441	19,868	(11,427)	
	RESEARCH DIV	0	2,115	0	2,115	12,642	3,000	12,642	(9,642)	
	TOTAL	7,146	6,015	7,146	(1,131)	41,628	11,441	41,628	(30,187)	
APR 78	FISHERIES DIV	5,090	0	5,090	(5,090)	14,208	0	14,208	(14,208)	
	OPERATIONS DIV	12,971	8,872	12,971	(4,099)	32,839	17,313	32,839	(15,526)	
	RESEARCH DIV	12,437	4,377	12,437	(8,060)	25,079	7,377	25,079	(17,702)	
	TOTAL	30,498	13,249	30,498	(17,249)	72,126	24,690	72,126	(47,436)	
MAY 78	FISHERIES DIV	4,856	0	4,856	(4,856)	19,064	0	19,064	(19,064)	
	OPERATIONS DIV	12,609	9,535	12,609	(3,074)	45,448	26,848	45,448	(18,600)	
	RESEARCH DIV	7,818	10,056	7,818	2,238	32,897	17,433	32,897	(15,464)	
	TOTAL	25,283	19,591	25,283	(5,692)	97,409	44,281	97,409	(53,128)	
JUN 78	FISHERIES DIV	6,119	0	6,119	(6,119)	25,183	0	25,183	(25,183)	
	OPERATIONS DIV	7,069	10,207	7,069	3,138	52,517	37,055	52,517	(15,462)	
	RESEARCH DIV	2,786	8,836	2,786	6,050	35,683	26,269	35,683	(9,414)	
	TOTAL	15,974	19,043	15,974	3,069	113,383	63,324	113,383	(50,059)	

FINANCIAL PLAN AND STATUS
BY MONTH, BY SUMMARY CHARGE

PAGE 4

CONTRACT DESCRIPTION	REPORTING ORGN.	CONTRACT NO.	REPORT DATES
	RUPINDER RANGAR		ITERM (SPAN)= 01APR77 ONWARDS
LEVEL/SUMMARY ITEM= 1/		NORDCO RESEARCH	ICUT OFF DATE= 01AUG78
			IRELEASE DATE= 18AUG78

MONTH	CHARGE NUMBER	INCREMENTAL COST X 1 ACTUAL	INCREMENTAL COST X 1 PLANNED	INCREMENTAL COST X 1 LATEST REVISED EST.	INCREMENTAL COST X 1 (OVER) UNDER PLAN	CUMULATIVE COST X 1 ACTUAL	CUMULATIVE COST X 1 PLANNED	CUMULATIVE COST X 1 LATEST REVISED EST.	CUMULATIVE COST X 1 (OVER) UNDER PLAN	REMARKS
JUL 78	FISHERIES DIV	3,421	0	3,421	(3,421)	28,614	0	28,614	(28,614)	
	OPERATIONS DIV	2,287	7,055	2,287	4,768	54,804	44,110	54,804	(10,694)	
	RESEARCH DIV	1,291	8,364	1,291	7,073	36,974	34,633	36,974	(2,341)	
	TOTAL	7,009	15,419	7,009	8,410	120,392	78,743	120,392	(41,649)	
AUG 78	OPERATIONS DIV	0	3,575	0	3,575	54,804	47,685	54,804	(7,119)	
	RESEARCH DIV	0	8,371	0	8,371	36,974	43,004	36,974	6,030	
	TOTAL	0	11,946	0	11,946	120,392	90,689	120,392	(29,703)	
SEP 78	OPERATIONS DIV	0	3,489	0	3,489	54,804	51,174	54,804	(3,630)	
	RESEARCH DIV	0	8,069	0	8,069	36,974	51,073	36,974	14,099	
	TOTAL	0	11,558	0	11,558	120,392	102,247	120,392	(18,145)	
OCT 78	OPERATIONS DIV	0	3,575	0	3,575	54,804	54,749	54,804	(55)	
	RESEARCH DIV	0	8,340	0	8,340	36,974	59,413	36,974	22,439	
	TOTAL	0	11,915	0	11,915	120,392	114,162	120,392	(6,230)	
NOV 78	OPERATIONS DIV	0	3,482	0	3,482	54,804	58,231	54,804	3,427	
	RESEARCH DIV	0	8,084	0	8,084	36,974	67,497	36,974	30,523	
	TOTAL	0	11,566	0	11,566	120,392	125,728	120,392	5,336	
DEC 78	OPERATIONS DIV	0	3,609	0	3,609	54,804	61,840	54,804	7,036	
	RESEARCH DIV	0	8,364	0	8,364	36,974	75,861	36,974	38,887	
	TOTAL	0	11,973	0	11,973	120,392	137,701	120,392	17,309	
JAN 79	OPERATIONS DIV	0	3,575	0	3,575	54,804	65,415	54,804	10,611	
	RESEARCH DIV	0	2,740	0	2,740	36,974	78,601	36,974	41,627	
	TOTAL	0	6,315	0	6,315	120,392	144,016	120,392	23,624	
FEB 79	OPERATIONS DIV	0	3,253	0	3,253	54,804	68,668	54,804	13,864	
	TOTAL	0	3,253	0	3,253	120,392	147,269	120,392	26,877	

FINANCIAL PLAN AND STATUS
BY MONTH, BY SUMMARY CHARGE

PAGE 9

CONTRACT DESCRIPTION	REPORTING ORGN.	CONTRACT NO.	REPORT DATES
	RUPINDER RANGAR		ITERM (SPAN)= 01APR77 ONWARDS
			ICUT OFF DATE= 01AUG78
LEVEL/SUMMARY ITEM= 1/		NORDCO RESEARCH	IRELEASE DATE= 18AUG78

		INCREMENTAL COST X 1				CUMULATIVE COST X 1				
MONTH	CHARGE NUMBER	ACTUAL	PLANNED	LATEST REVISED EST.	(OVER) UNDER PLAN	ACTUAL	PLANNED	LATEST REVISED EST.	(OVER) UNDER PLAN	REMARKS
MAR 79	OPERATIONS CIV	0	3,609	0	3,609	84,804	72,277	84,804	17,473	
	TOTAL	0	3,609	0	3,609	120,392	150,878	120,392	30,486	
	TOTAL PERIOD					120,392	150,878	120,392	30,486	

MANAGEMENT SUMMARY REPORT PAGE *

CONTRACT DESCRIPTION	* REPORTING ORGN.	* CONTRACT NO.	* REPORT DATES
	* RUPINDER RANGAR		*TERM (SPAN)= 01APR77 ONWARDS
			*CUT OFF DATE= 01AUG78
LEVEL/SUMMARY ITEM= 2/		OPERATIONS DIV	*RELEASE DATE= 18AUG78

ITEM	* COST OF WORK $/1							SCHEDULE																
	* WORK PERFORMED TO DATE			* TOTALS AT COMPLETION			*	*	* S-SCHED COMPL DATE --TOTAL															
									* A-ACTUAL COMPL DATE --ITEM															
									* E-EARLIEST COMPL DATE--CRITICAL															
									* L-LATEST COMPL DATE --ITEM															
							*LATEST	*PROJECTED	*CRIT															
	*VALUE	*ACTUAL COST	*(OVERRUN) *UNDERRUN	*PLANNED COST	REV EST	*(OVERRUN) UNDERRUN	*SLACK UNITS	COMPL DATE	*PI *YI	JF	MA	MJ	J.	AS	ON	DJ	F	MA	MJ	J	AS	ON	D	012JIL IY
LEV 2			0.84			0.84		01APR79	I				.						S					I
OPERATIONS DIV	37,117	5,674	31,243	37,117	5,674	31,243	.0	01APR79	I				.						E					I
								01APR79	I				.						L					I
LEV 1									I				.											I
OVHD OPERATIONS	0	0	0	0	0	0			I				.											I
								01JUN78	I				S .											I
LEV 3			0.76			0.76		01JUN78	I				E .											I
18-741	11,286	2,711	8,575	11,286	2,711	8,575	.0	01JUN78	I				L .											I
								01JUN78	I				S .											I
LEV 3			0.84			0.84		01JUN78	I				E .											I
21-779	5,405	856	4,549	5,405	856	4,549	.0	01JUN78	I				L .											I
								01APR79	I				.						S					I
LEV 3			0.97			0.97		01APR79	I				.						E					I
28-76N	14,207	389	13,818	14,207	399	13,818	.0	01APR79	I				.						L					I
								16JUL78	I				S.											I
LEV 3			0.69			0.69		16JUL78	I				E.											I
44-746	6,219	1,918	4,301	6,219	1,918	4,301	.0	16JUL78	I				L.											I

TIME NOW

MANAGEMENT SUMMARY REPORT PAGE 5

CONTRACT DESCRIPTION	REPORTING ORGN.	CONTRACT NO.	REPORT DATES
	RUPINDER RANGAR		TERM (SPAN)= 01APR77 ONWARDS
			CUT OFF DATE= 01AUG78
LEVEL/SUMMARY ITEM= 2/	RESEARCH DIV		RELEASE DATE= 18AUG78

ITEM	COST OF WORK $/1							SCHEDULE															
	WORK PERFORMED TO DATE			TOTALS AT COMPLETION				S-SCHED COMPL DATE --TOTAL															
								A-ACTUAL COMPL DATE --ITEM															
								E-EARLIEST COMPL DATE--CRITICAL															
								L-LATEST COMPL DATE --ITEM															
	VALUE	ACTUAL COST	(OVERRUN) UNDERRUN	PLANNED COST	LATEST REV EST	PROJECTED (OVERRUN) UNDERRUN	CRIT SLACK UNITS	COMPL DATE	PI	1978								1979						012JIL
									Y	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	IY
LEV 2			0.87			0.87		11JAN79	I											S													I
RESEARCH DIV	67.601	8.762	58.839	67.601	8.762	58.839	.0	11JAN79	I											E													I
									I											L													I
LEV 3									I																									I
OVRHD RESEARCH	0	0	0	0	0	0			I																									I
								11JAN79	I											S													I
LEV 3			0.95			0.95		11JAN79	I											E													I
12-78G	62.058	3.322	58.736	62.058	3.322	58.736	.0	11JAN79	I											L													I
								02MAY78	I		S																							I
LEV 3			0.90			0.90		02MAY78	I		E																							I
33-78P	1.643	168	1.475	1.643	168	1.475	.0	02MAY78	I		L																							I
								15JUN78	I		S																							I
LEV 3			(0.35)			(0.35)		15JUN78	I		E																							I
78-77I	3.900	5.272	(1.372)	3.900	5.272	(1.372	.0	15JUN78	I		L																							I

TIME NOW

MANAGEMENT SUMMARY REPORT PAGE 3

CONTRACT DESCRIPTION	REPORTING ORGN	CONTRACT NO	REPORT DATES
	RUPINDER RANGAR		TERM (SPAN)= 01APR77 ONWARDS
			CUT OFF DATE= 01AUG78
LEVEL/SUMMARY ITEM= 2/		FISHERIES DIV	RELEASE DATE= 18AUG78

ITEM	COST OF WORK $/1							SCHEDULE															
	WORK PERFORMED TO DATE			TOTALS AT COMPLETION				S-SCHED COMPL DATE --TOTAL A-ACTUAL COMPL DATE --ITEM E-EARLIEST COMPL DATE--CRITICAL L-LATEST COMPL DATE --ITEM															
	VALUE	ACTUAL COST	(OVERRUN) UNDERRUN	PLANNED COST	LATEST REV EST	PROJECTED (OVERRUN) UNDERRUN	MOST CRIT SLACK UNITS	COMPL DATE	PI	1978								1979						01231L
									YI	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	C	N	D	IV
LEV 2								01JAN79	I										S														I
FISHERIES DIV	0	2,325	(2,325)	0	2,325	(2,325	.0	01JAN79	I										E														I
								01JAN79	I										L															I
LEV 3									I																								I
JV&HD FISHERIES	0	0	0	0	0	0			I																								I
LEV 3								01JAN79	I										S														I
52-76N	0	2,325	(2,325)	0	2,325	(2,325	.0	01JAN79	I										E														I
								01JAN79	I										L															I

TIME NOW

PROGRAM OUTLOOK GRAPH

TIME VS DOLLARS

PAGE NO 7

RUN DATE 19AUG78
ASOF DATE 01AUG78

SUBNET= 01APR77 ICEBERG SCOURING GH INHS PJT OPERATIONS DIV 2876N

ACC. PERIODS — DOLLARS X 1,000

ACC. PERIODS	10	20	30	40	50	60	70	80	90	100
APR 77	A									
MAY 77	A									
JUN 77	A									
JUL 77	A									
AUG 77	A									
SEP 77	A									
OCT 77	A									
JAN 78	A									
FEB 78	A									
MAR 78	A									
APR 78	B A									
MAY 79	A B									
JUN 79	A	B								
JUL 78	A		B							
AUG 78	A			B						
SEP 79	A				B					
OCT 78	A					B				
NOV 78	A						B			
DEC 78	A							B		
JAN 79	A								B	
FEB 79	A									B

PROGRAM OUTLOOK GRAPH

TIME VS DOLLARS

PAGE NO 9

RUN DATE 18AUG78

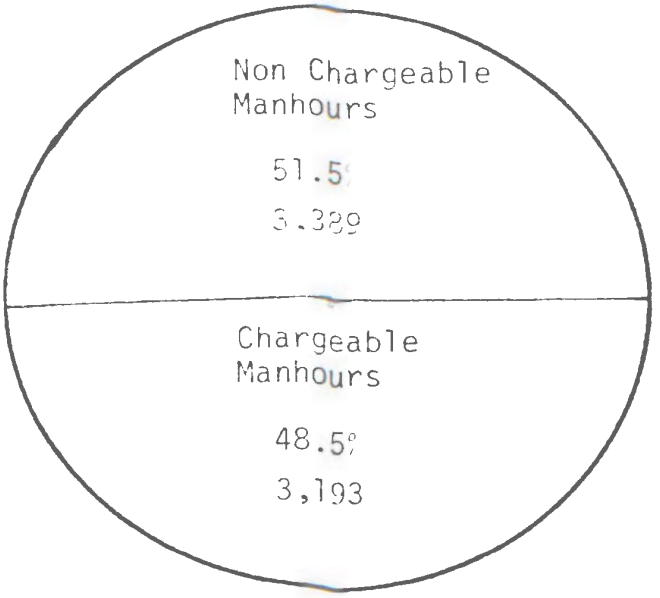
SUBNET- 01APR77 ICEBERG SCOURING GH INHS PJT OPERATIONS DIV 2876N

FINAL SUBNET OUTLOOK

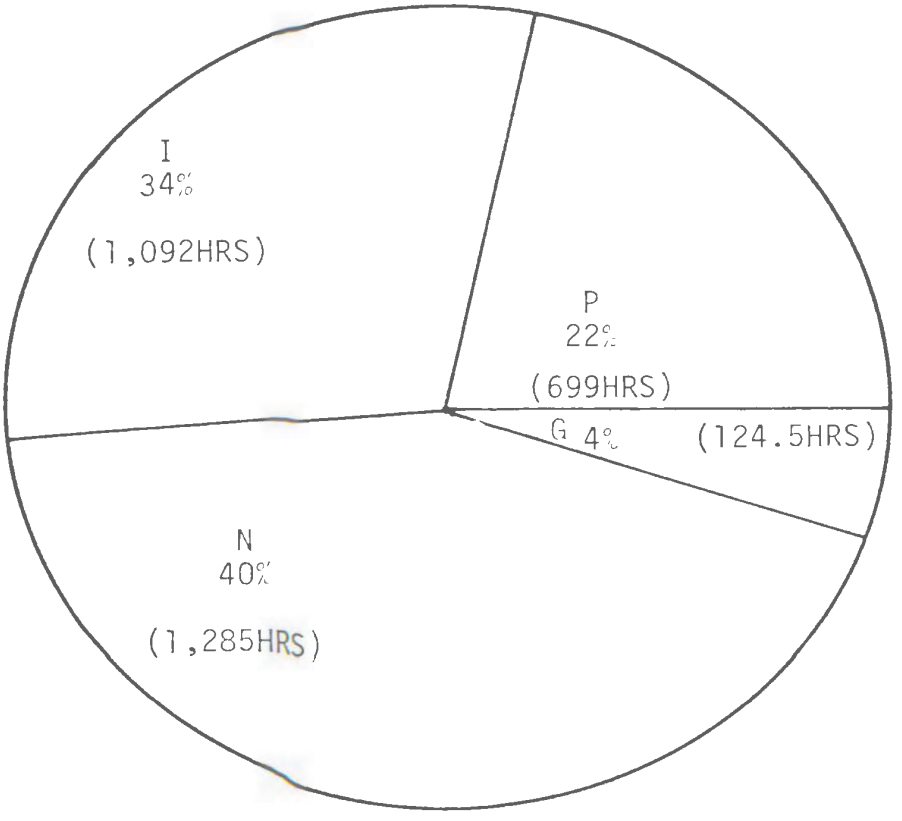
LEGEND	ITEM	DOLLARS X 1
A - ACTUALS TO DATE	ACTUALS TO DATE	9,765
B - BUDGETED	BUDGETED TO DATE	23,576
C - OUTLOOK	TO DATE OVER(UNDER)RUN	13,811
	OUTLOOK TO COMPLETION	9,765
	BUDGET TO COMPLETION	52,193
	PRED.OVER/UNDER(-)RUN	42,428-
	VALUE OF WORK	52,193

APPENDIX 59
P-1

NORDCO Manpower Utilization State (less Shoe Cove, MGT & ADM)

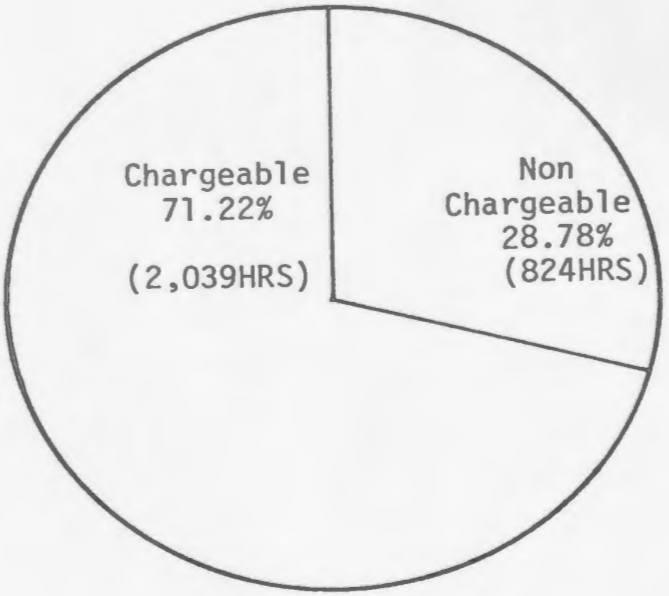


Breakdown of Chargeable Manhours

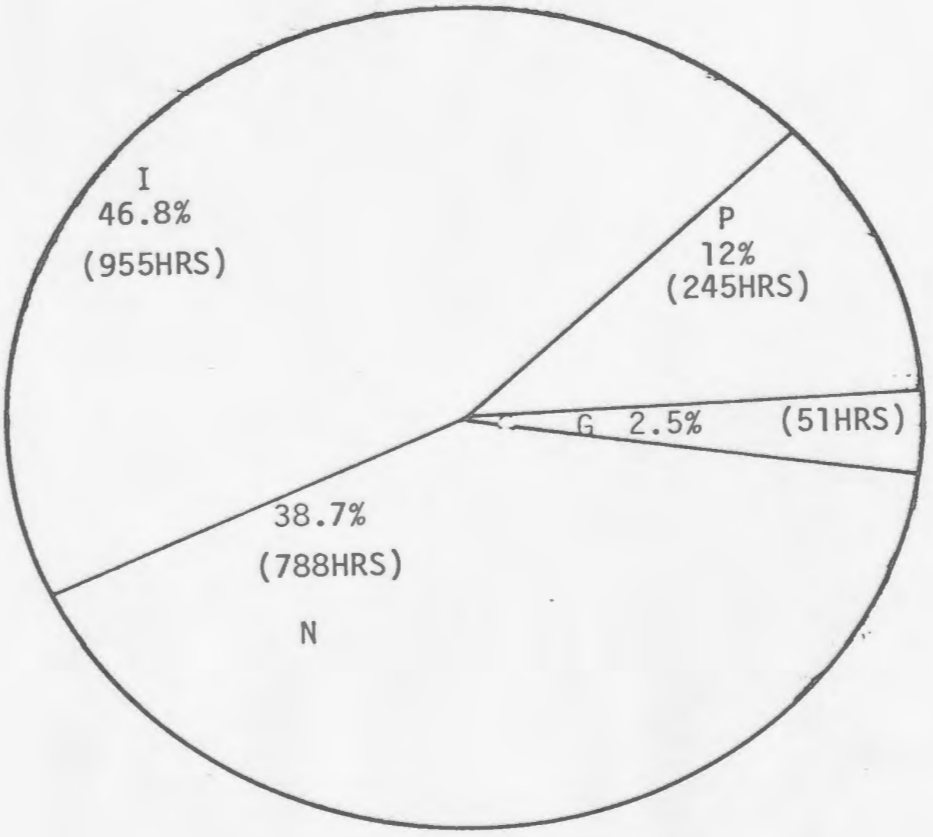


APPENDIX D9
P-2

OPERATIONS DIVISION

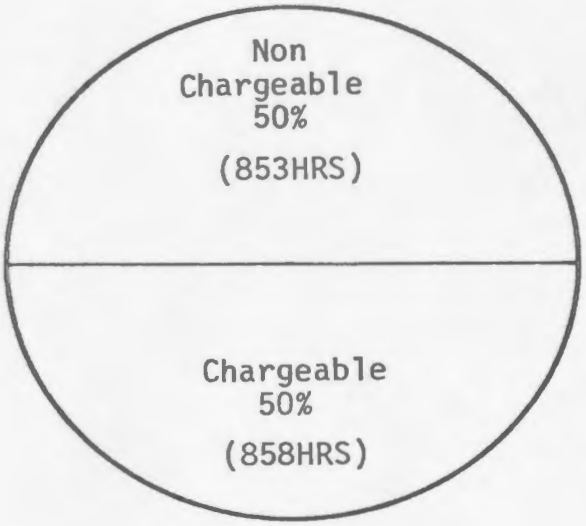


Breakdown of
Chargeable
Manhours

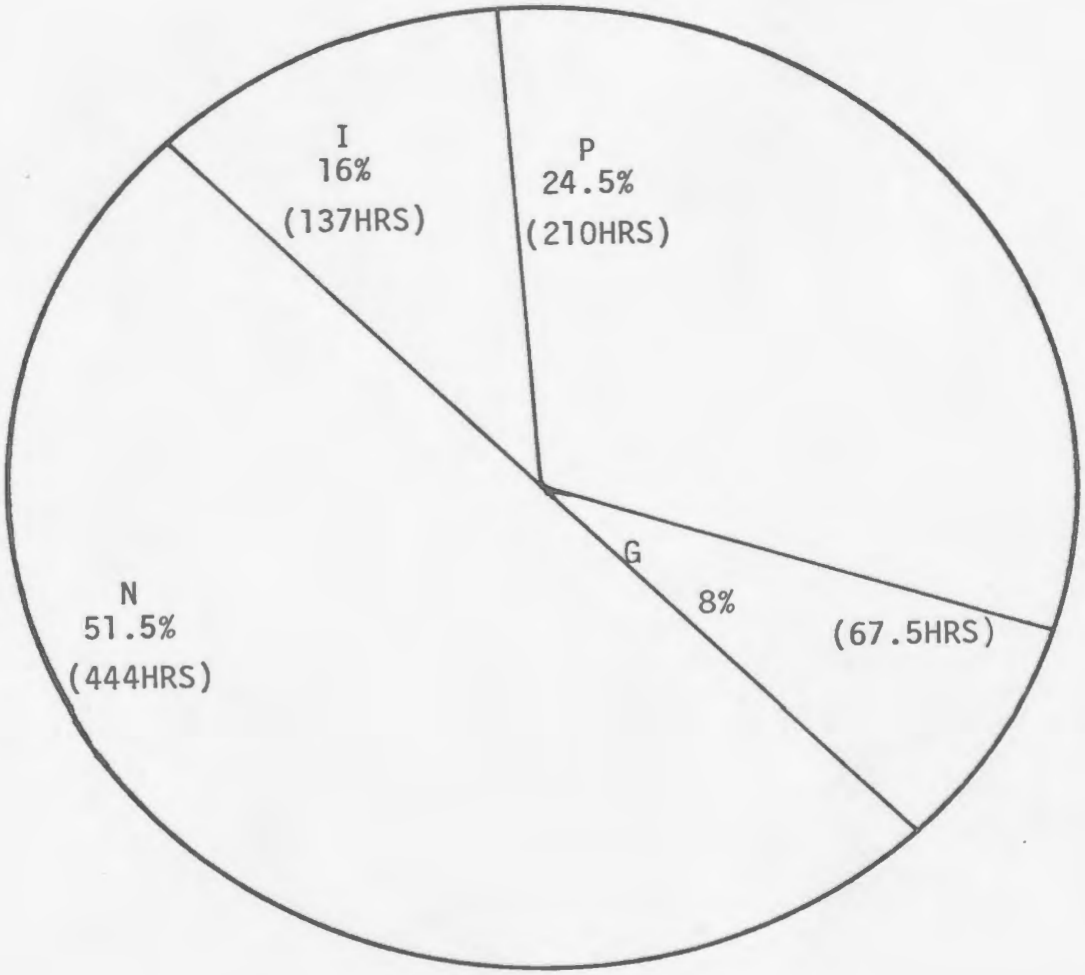


APPENDIX D9
P-3

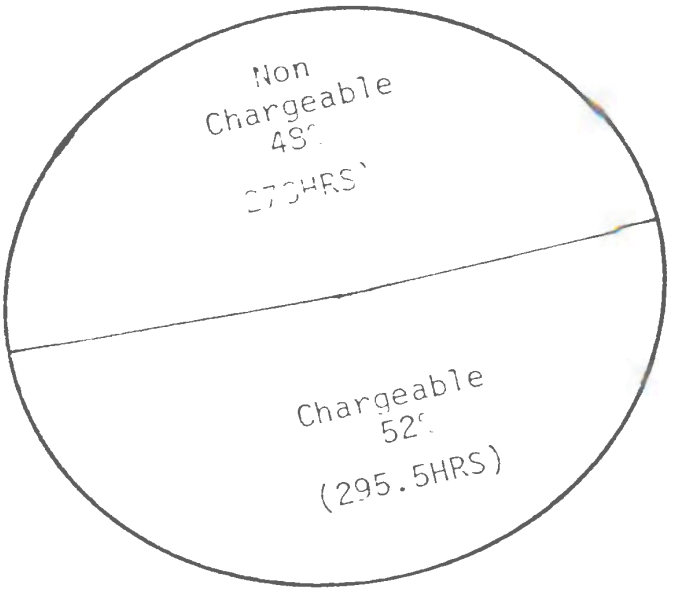
RESEARCH DIVISION



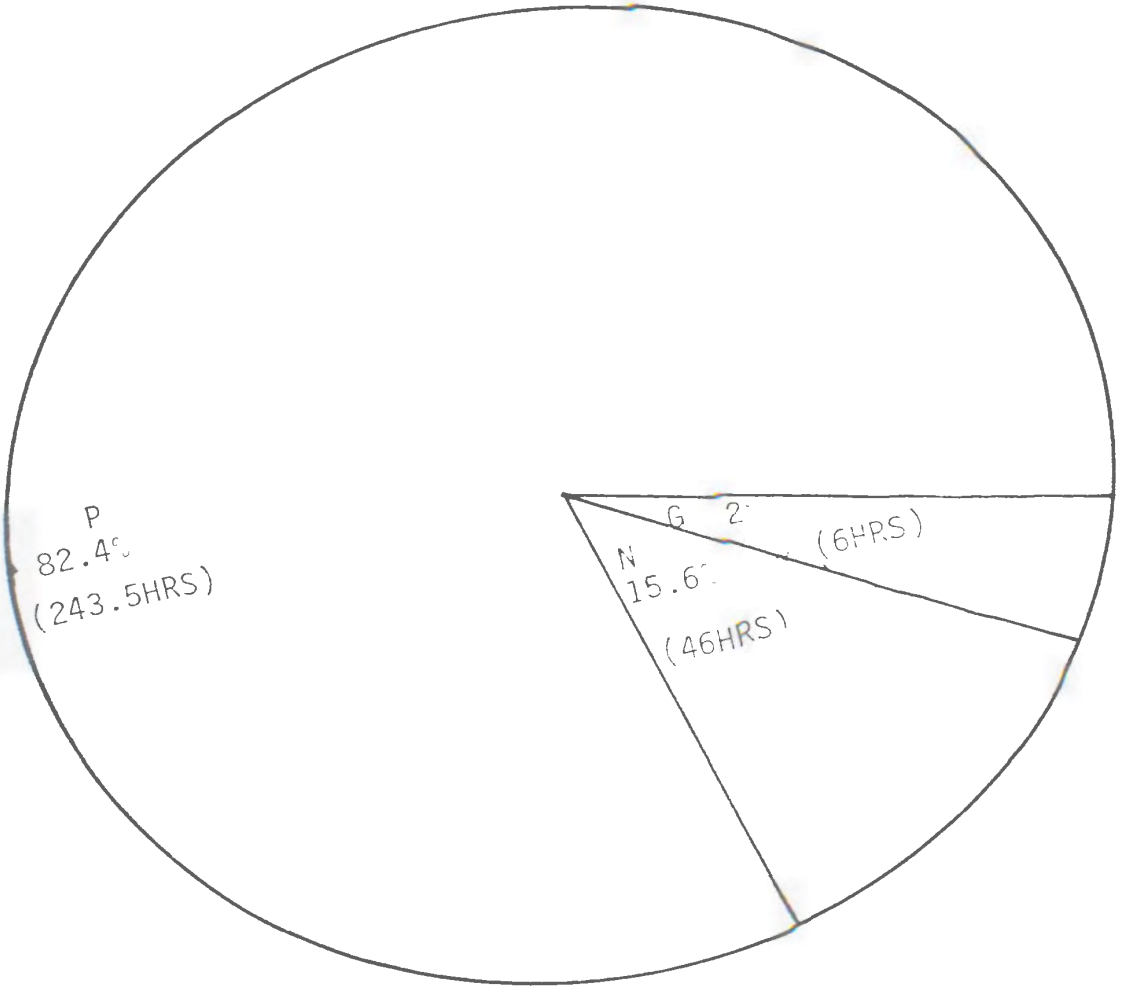
Breakdown of Chargeable Manhours



FISHERIES DIVISION

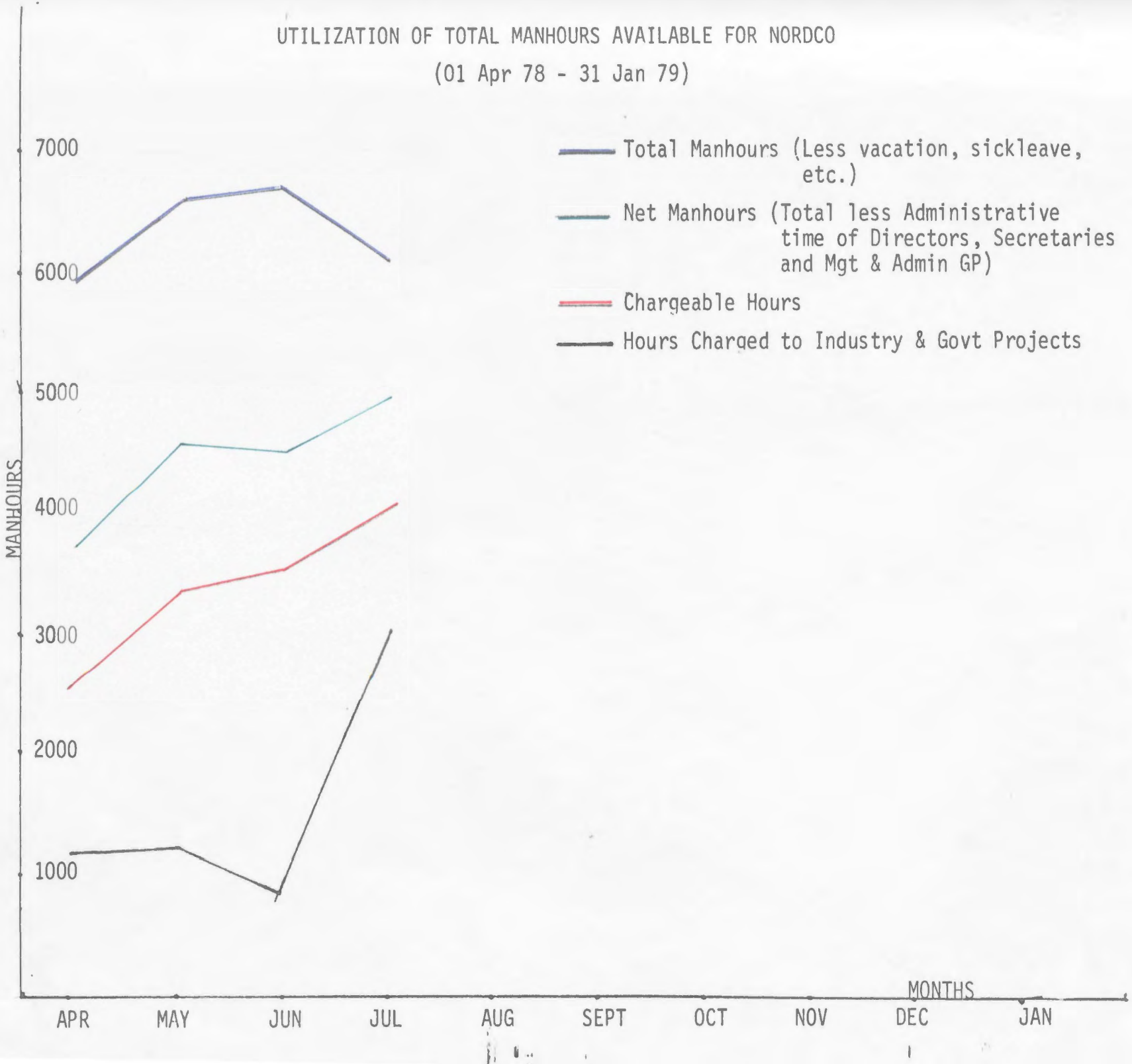


Breakdown of Chargeable Manhours



UTILIZATION OF TOTAL MANHOURS AVAILABLE FOR NORDCO

(01 Apr 78 - 31 Jan 79)



APPENDIX E

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - PMS IV MOD 4 18AUG78 0001
WHEN ASSUMPTIONS ARE MADE, THE MODIFIED RECORD IS PRINTED

```
JJ PROJECT
01  PROJECT                                                    2876N
01  PROJECT                                                    5276N
01  PROJECT                                                    2177P
01  PROJECT                                                    3877I
01  PROJECT                                                    1278G
01  PROJECT                                                    1878I
01  PROJECT                                                    3378P
01  PROJECT                                                    4478G
01  PROJECT                                                    OVHD1
01  PROJECT                                                    OVHD4
01  PROJECT                                                    OVHD5
05 JJ770407007                                                 *
15  01APR77 ICEBERG SCOURING GH INHS PJT OPERATIONS DIV        2876N
15  15DEC76 AQUACULTURE OS INHS PJT FISHERIES DIV              5276N
15  01JAN79 STRAIT OF BELLE ISLE STUDY  RE/MC (OPS) PROPOSAL OPS  2177P
15  01JAN78 CONTINUOUS SHORE-FAST ICE  RG  INDS PJT RESEARCH   3877I
15  26APR78 SEASAT SUBSYSTEM INTEGRATION  LC(GP4) RSH  GOVT PJT RESEARCH1278G
15  01FEB78 HUNTEC MARINE SERVICES  NB  INDS PJT OPERATIONS DIV  1878I
15  14APR78 STUDY CORRELATION BETWEEN SEAL MIGRN & SEA ICE  TK PPSL RSCH3378P
15  31MAY78 HARBOUR GRACE FISH LANDING FACILITY  NB  GOVT PJT OPS  4478G
15  01APR78 OPERATIONS OVERHEAD                                OVHD1
15  01APR78 RESEARCH OVERHEAD                                  OVHD4
15  01APR78 FISHERIES OVERHEAD                                 OVHD5
30 S        OHD1A                  01APR78OPS START OF PROJECT  OVHD1
30 S        OHD1B                  01APR78FSH START OF PROJECT  OVHD4
30 S        OHD1C                  01APR78FSH START OF PROJECT  OVHD5
30 F    OHD2A                          OPS END OF PROJECT       OVHD1
```

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - PMS IV MOD 4 18AUG78 0002
WHEN ASSUMPTIONS ARE MADE, THE MODIFIED RECORD IS PRINTED

30 F	CHD2D		RSH END OF PROJECT	OVHD4
30 F	7HD2C		FSH END OF PROJECT	OVHD5
30	OHC1ADHD2A 365		OPS ACCOUNTING PERIOD	OVHD1
30	CHD1HCHD2P 365		RSH ACCOUNTING PERIOD	OVHD4
30	OHC1COHD2C 365		FSH ACCOUNTING PERIOD	OVHD5
30 S	28401	01APR77OPS	START OF PROJECT	2876N
30 S	52601	01APR77FSH	START OF PROJECT	5276N
30 S	21701	03JAN78OPS	START OF PROPOSAL	2177P
30 S	38701	01JAN78RSH	START OF PROJECT	3877I
30 S	12401	26APR78FSH	START OF PROJECT	1278G
30 S	14401	31FEB78OPS	START OF PROJECT	1678I
30 S	33401	14APR78RSH	START OF PROJECT	3378P
30 S	44801	31MAY78OPS	START OF PROJECT	4478G
30 F	28603		OPS END OF PROJECT	2876N
30 F	52603		RSH END OF PROJECT	5276N
30 F	21702		OPS END OF PROPOSAL PHASE	2177P
30 F	38704		RSH END OF PROJECT	3877I
30 F	12802		RSH END OF PROJECT	1278G
30 F	16802		OPS END OF PROJECT	1678I
30 F	33802		RSH END OF PROPOSAL	3378P
30 F	44803		OPS END OF PROJECT	4478G
30	28601 28602 365		OPS PRIOR WORK	2876N
30	28602 28603 365		OPS PRESENT WORK	2876N
30	52601 52602 365		FSH PROJECT WORK YR1	5276N
30	52602 52603 275		FSH PROJECT WORK YR2	5276N
30	21701 21702 149		OPS PROPOSAL WORK	2177P
30	38701 38702 46		RSH PRELIMINARY STUDY	3877I
30	38702 38701 44		FSH FIELD WORK	3877I

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - PMS IV VER 1 MOD A 0001
WHEN ASSUMPTIONS ARE MADE. THE MODIFIED RECORD IS PRINTED

```
55 PROJECT
51  PROJECT                                                    2876N
51  PROJECT                                                    5276N
51  PROJECT                                                    2177P
51  PROJECT                                                    3877I
51  PROJECT                                                    1278G
51  PROJECT                                                    1878I
51  PROJECT                                                    3378P
51  PROJECT                                                    4478G
51  PROJECT                                                    OVHD1
51  PROJECT                                                    OVHD4
51  PROJECT                                                    OVHD5
55 00770407007                                                 *
61 1NORDCO RESEARCH                          NORDCO
61 2OPERATIONS DIV       1NORDCO RESEARCH    NORDCO
61 2RESEARCH DIV         1NORDCO RESEARCH    NORDCO
61 2FISHERIES DIV        1NORDCO RESEARCH    NORDCO
61 3OVRHD FISHERIES      2FISHERIES DIV      FISHRY
61 3OVRHD RESEARCH       2RESEARCH DIV       RESRCH
61 3OVRHD OPERATIONS     2OPERATIONS DIV     OPERAN
61 329-76N               2OPERATIONS DIV     OPERAN
61 352-76N               2FISHERIES DIV      FISHRY
61 321-77P               2OPERATIONS DIV     OPERAN
61 138-77I               2RESEARCH DIV       RESRCH
61 312-78G               2RESEARCH DIV       RESRCH
61 319-79I               2OPERATIONS DIV     OPERAN
61 331-78P               2RESEARCH DIV       RESRCH
```

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - PMS IV VER 1 MOD 4 0002
WHEN ASSUMPTIONS ARE MADE, THE MODIFIED RECORD IS PRINTED

```
61 304-79G                 2OPERATIONS DIV     OPERAN
61 402 29-76MATERIALS      329-76N             OPERAN
61 407 29-76 DP PAD        329-76N             OPERAN
61 403 29-76*TRAVEL        329-76N             OPERAN
61 405 29-76INSTR CNTL     329-76N             OPERAN
61 401 29-76 PJT WORK      329-76N             OPERAN
61 402 29-76 PRIOR         329-76N             OPERAN
61 401 29-76 PRIOR         329-76N             OPERAN
61 401 52-76PJT WORK       352-76N             FISHRY
61 402 52-76 PRIOR         352-76N             FISHRY
61 403 52-76 TRAVEL        352-76N             FISHRY
61 401 52-76 PRIOR         352-76N             FISHRY
61 402 52-76MATERIALS      352-76N             FISHRY
61 403 21-77TRAVEL         321-77P             OPERAN
61 407 21-77CONSULTANT     321-77P             OPERAN
61 402 21-77MATERIAL       321-77P             OPERAN
61 401 21-77PPSL PHASE     321-77P             OPERAN
61 402 21-77 PRIOR         321-77P             OPERAN
61 401 21-77 PRIOR         321-77P             OPERAN
61 401 18-77 PRIOR         339-77I             RESRCH
61 402 18-77 PRIOR         339-77I             RESRCH
61 403 18-77 TRAVEL        339-77I             RESRCH
61 406 18-77COMPUTER       339-77I             RESRCH
61 402 18-77MATERIAL       339-77I             RESRCH
61 401 18-77OPER REPRT     339-77I             RESRCH
61 406 12-78COMPUTER       312-78G             RESRCH
61 407 12-78CONSULTANT     312-78G             RESRCH
```

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - PMS IV VER 1 MOD 4 0004
WHEN ASSUMPTIONS ARE MADE, THE MODIFIED RECORD IS PRINTED

62	USPROPOSALS	COST	07	F				
62	JAPROPOSALS	COST	04	P	COST	05	P	COST 06 P
62	JPROPOSALS	COST	08	P				
63	01INDUSTRY PROJECTS	RBO	01	I	RGO	01	I	DJFO 01 I
63	02INDUSTRY PROJECTS	GMO	01	I	WMO	01	I	DCSO 01 I
63	03INDUSTRY PROJECTS	STO	01	I				
63	04INDUSTRY PROJECTS	COST	01	I	COST	02	I	COST 03 I
63	05INDUSTRY PROJECTS	COST	07	I				
63	06INDUSTRY PROJECTS	COST	04	I	COST	05	I	COST 06 I
63	07INDUSTRY PROJECTS	COST	08	I				
63	01IN-HOUSE PROJECTS	DRO	01	N	DSO	01	N	BMSO 01 N
63	02IN-HOUSE PROJECTS	TKO	01	N	JJFO	01	N	CIO 01 N
63	03IN-HOUSE PROJECTS	COST	01	N	COST	02	N	COST 03 N
63	04IN-HOUSE PROJECTS	COST	07	N				
63	05IN-HOUSE PROJECTS	COST	08	N				
63	06IN-HOUSE PROJECTS	COST	04	N	COST	05	N	COST 06 N
63	01GOVT PROJECTS	NBO	01	G	SCO	01	G	LDOS 01 G
63	02GOVT PROJECTS	RMO	01	G	RSO	01	G	SYO 01 G
63	03GOVT PROJECTS	RNGP	101	G	DMAN	01	G	SYOS 01 G
63	04GOVT PROJECTS	TEC	01	G	RMCS	01	G	WCO 01 G
63	05GOVT PROJECTS	COST	01	G	COST	02	G	COST 03 G
63	06GOVT PROJECTS	COST	07	G				
63	07GOVT PROJECTS	COST	04	G	COST	05	G	COST 06 G
63	08GOVT PROJECTS	COST	08	G				
64	01FOREIGN MANPOWER	COST	01P	F	COST	01P	I	COST 01P N
64	02FOREIGN MANPOWER	COST	01P	G				
64	01MATERIALS	COST	02	F	COST	02	I	COST 02 N

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - RUG IV VER I MOD A 0007
WHEN ASSUMPTIONS ARE MADE, THE MODIFIED RECORD IS PRINTED

04	[illegible]	COST	02	G						
04	DIR AVEL	COST	03	F	COST	03	I	COST	03	N
04	DTRAVEL	COST	03	G						
04	DCONSULTANT	COST	07	F	COST	07	I	COST	07	N
04	DRCONSULTANT	COST	07	G						
04	DIRMAINTNCE COSTS	NBD	01	G	RBD	01	I	CLBD	01	P
04	[illegible] COSTS	WCD	01	P	SCD	01	G	DDD	01	P
04	[illegible] COSTS	LDDS	01	G	WDD	01	G	RGD	01	I
04	[illegible] COSTS	CID	01	N	DJFD	01	P	DJFD	01	I
04	[illegible] COSTS	JJFD	01	N	TKD	01	P	TKD	01	I
04	[illegible] COSTS	[illegible]	01	I	PMD	01	G	WMD	01	I
04	[illegible]	[illegible]	01	P	DWD	01	N	DSD	01	N
04	[illegible]	RSD	01	P	JGD	01	G	DCSD	01	I
04	[illegible] COSTS	DMCD	01	N	SYD	01	G	STD	01	I
04	[illegible] COSTS	SYD	01	F	ENGF	01	G	DMAN	01	G
04	[illegible]	SYDS	01	C	TEC	01	G	EMDS	01	G
04	DIRECT OTHER COSTS	COST	02P	F	COST	02P	N	COST	02P	I
04	DIRECT OTHER COSTS	COST	02P	G						
04	DIRCONTRACT	COST	08	F	COST	08	I	COST	03	N
04	DCONTRACT	COST	08	G						
04	DINSTRUMENT RENTAL OTHERS	COST	05	F	COST	05	I	COST	05	N
04	DINSTRUMENT RENTAL OTHERS	COST	05	G						
04	DINSTRUMENT RENTAL NORDCO	COST	04	F	COST	04	I	COST	04	N
04	DINSTRUMENT RENTAL NORDCO	COST	04	G						
04	DICOMPUTER COSTS	COST	06	F	COST	06	I	COST	06	N
04	DICOMPUTER COSTS	COST	06	G						

06 3 NPD 01 G 77004 040714 79004 042857

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - DMS IV VER 1 MOD 4 0005
WHEN ASSUMPTIONS ARE MADE, THE MODIFIED RECORD IS PRINTED

```
66  A        MOD   01  G  77004 040714        78004 042857
66  B        SUB   01  I  77004 022143        78004 023571
66  A        DIS   01  I  77004 022143        78004 023571
66  C        CLR7  01  D  77004 019204        78004 020714
66  A        CLR7  01  D  77004 019204        78004 020714
66  B        MOS   01  D  77004 025714        78004 027142
66  A        MOS   01  D  77004 025714        78004 027142
66  C        SUB   01  G  77004 037143        78004 039285
66  A        SUB   01  G  77004 037143        78004 039285
66  C        DIS   01  D  77004 022143        78004 023571
66  B        DIS   01  D  77004 022143        78004 023571
66  B        LOAD  01  G  78004 014664
66           LOAD  01  G  78004 014664
66  C        MOS   01  G  77004 022143        78004 023571
66  B        SUB   01  I  77004 026427        78004 027857
66  A        SUB   01  I  77004 026427        78004 027857
66  A        MOD   01  G  77004 022143        78004 023571
66  B        CIO   01  N  77004 018571        78004 020000
66  A        CIO   01  N  77004 018571        78004 020000
66  C        CLR7  01  D  77004 027143        78004 028772
66  A        CLR7  01  D  77004 027143        78004 028772
66  B        CLR7  01  I  77004 027143        78004 028772
66  A        CLR7  01  I  77004 027143        78004 028772
66  B        LOAD  01  N  77004 071429        78004 075715
66  A        LOAD  01  N  77004 071429        78004 075715
66  C        TRD   01  D  77004 031429        78004 033571
66  A        TRD   01  D  77004 031429        78004 033571
```

LINES OF ASTERISKS FLAG ILLEGAL CHARACTERS - PMS IV VER 1 MOD 4 0011
WHEN ASSUMPTIONS ARE MADE, THE MODIFIED RECORD IS PRINTED

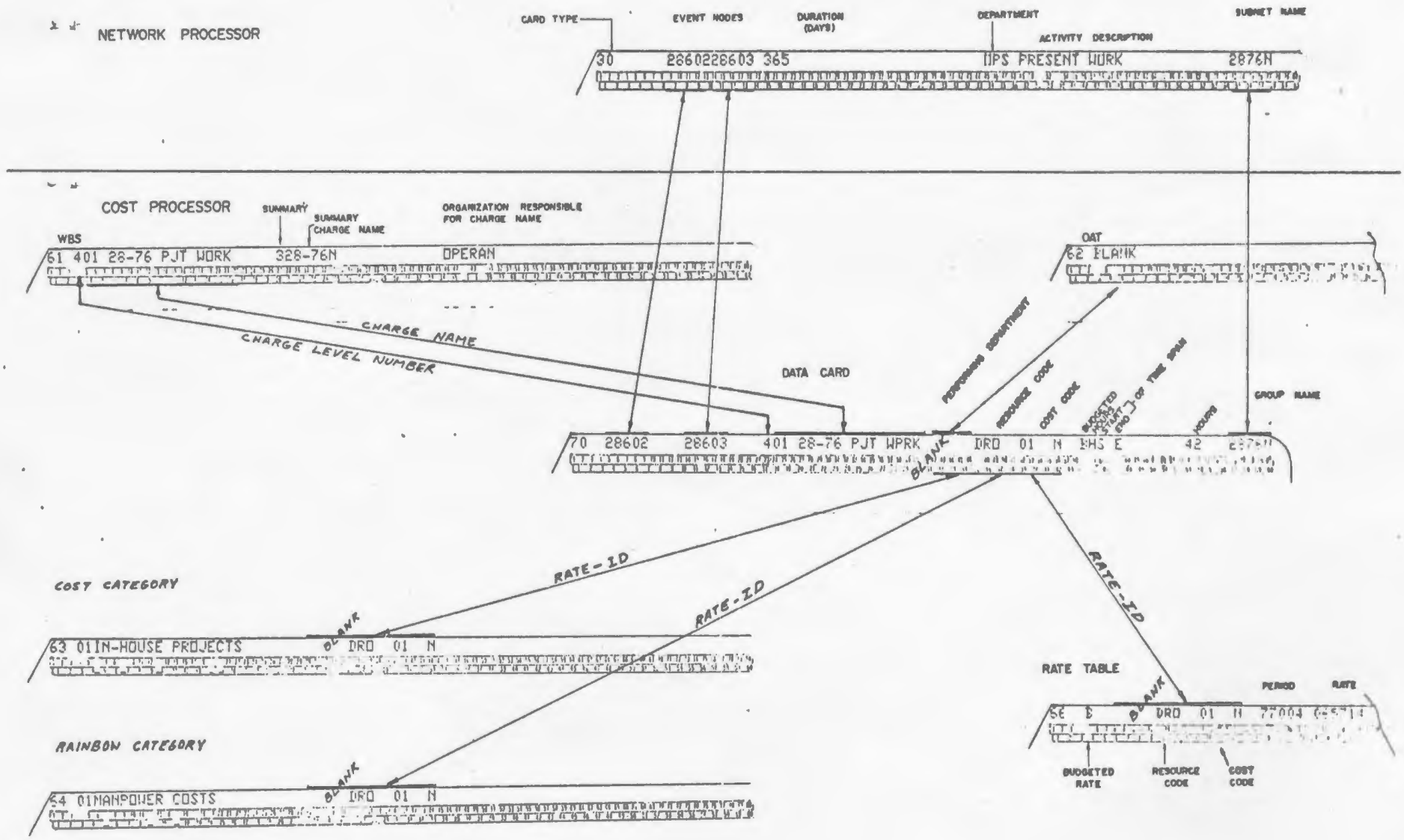
70	28600	28603	401	28-76 PJT WORK	DMSO	01	N	AH S 08	6	2876N	
70	28600	28603	401	28-76 PJT WORK	TKC	01	N	BH S E	336	2876N	
70	28600	28603	401	28-76 PJT WORK	DFO	01	N	BH S 16	42	2876N	
70	52600	52603	401	52-76PJT WORK	DSO	01	N	AH 1020	18	5276N	
70	52600	52603	401	52-76PJT WORK	DSO	01	N	AH S 10	70	5276N	
70	21701	21702	401	21-77PESL PHASE	SYO	01	P	BH S E	9	2177P	
70	21701	21702	401	21-77PESL PHASE	WCC	01	P	BH S E	113	2177P	
70	21701	21702	401	21-77PESL PHASE	DFO	01	P	BH S E	14	2177P	
70	21701	21702	401	21-77PESL PHASE	DDO	01	P	AH S 80	1	2177P	
70	21701	21702	401	21-77PESL PHASE	CLDO	01	P	AH S 80	30	2177P	
70	21701	21702	401	21-77PESL PHASE	BSO	01	P	AH S 80	6	2177P	
70	21701	21702	401	21-77PESL PHASE	WCO	01	P	AH S 80	4	2177P	
70	38701	38704	401	38-77DEFE REPRT	DJFC	01	I	AH S 50	62	3877I	
70	38701	38704	401	38-77DEFE REPRT	DCSC	01	I	AH S 50	4	3877I	
70	38701	38704	401	38-77DEFE REPRT	BGO	01	I	BH S E	140	3877I	
70	38701	38704	401	38-77DEFE REPRT	BGO	01	I	AH S E	41	3877I	
70	38701	38704	401	38-77DEFE REPRT	BGO	01	I	AH S E	44	3877I	
70	38701	38704	401	38-77DEFE REPRT	DJFC	01	I	AH S E	3	3877I	
70	38701	38704	401	38-77DEFE REPRT	STO	01	I	AH S E	46	3877I	
70	38701	38704	401	38-77DEFE REPRT	DJFC	01	I	AH S E	3	3877I	
70	38701	38704	401	38-77DEFE REPRT	DCSC	01	I	AH S E	1	3877I	
70	38701	38704	406	38-77COMPUTER	COST	06	I	BO*S E	3500	3877I	
70	38701	38704	406	38-77COMPUTER	COST	06	I	AC*S 55	4700	3877I	
70	38701	38704	406	38-77COMPUTER	COST	06	I	AT*S 55	4700	3877I	
70	12701	12702	406	12-78COMPUTER	COST	06	G	BO*S E	2500	1278G	
70	12701	12702	406	12-78COMPUTER	COST	06	G	AC*S E	2500	1278G	
70	12701	12702	406	12-78COMPUTER	COST	06	G	AT*S E	2500	1278G	

```
                                        OUTPUT MESSAGES - PMS IV VER 1 MOD 4                PAGE 001

12724 FOLLOWING REQUEST CARDS USED FOR REPORT(S)
                          *IRMR 31 01 03   FSH
                          *SORTA   X02,X36,X37
                          *TIMEREQ 00    13                                          PROJECT
12725 FOLLOWING REQUEST CARDS USED FOR REPORT(S)
                          *RESET  W
                          *IRMR 31 01 03   OPS
                          *SORTA   X02,X36,X37
                          *TIMEREQ 00    13                                          PROJECT
12725 FOLLOWING REQUEST CARDS USED FOR REPORT(S)
                          *RESET  F
                          *IRMR 31 01 03   FSH
                          *SORTA   X02,X36,X37
                          *TIMEREQ 00    13                                          PROJECT
12725 FOLLOWING REQUEST CARDS USED FOR REPORT(S)
```

APPENDIX F

Workup Scheme of Network-Cost Processor - NORDCO



APPENDIX G

DATA PROCESSING COMPARISON BETWLEN FULLY INTERFACED NETWORKS AND STAND ALONE NETWORDS

(NUMBER OF SUBNETS USED = 74)

	'STAND ALONE' NETWORK	INTERFACED NETWORK
Cards Read	2,265	2,339
SYSOUT Print Records	22,102	22,624
Account Utilization	0.2483 units	0.2256 units
CPU Time	6 min 59.01 sec	6 min 28.42 sec

STEPS	TIME	CORE	TIME	CORE
EDITTIME	0 MIN 01.36 SEC	64	0 MIN 01.29 SEC	64K
ORDER	0 MIN 02.18 SEC	128K	0 MIN 02.07 SEC	128K
PERTGEN	1 MIN 20.20 SEC	116K	1 MIN 36.53 SEC	116K
PROCESS	0 MIN 18.07 SEC	72K	0 MIN 44.90 SEC	72K
EDITCOST	0 MIN 02.02 SEC	28K	0 MIN 01.96 SEC	28K
EDITSORT	0 MIN 01.86 SEC	128K	0 MIN 01.77 SEC	128K
ORDFRC	0 MIN 01.30 SEC	52K	0 MIN 01.30 SEC	52K
COSTGEN	0 MIN 12.42 SEC	128K	0 MIN 11.96 SEC	128K
REDCOST	4 MIN 59.60 SEC	128K	3 MIN 46.64 SEC	128K
TOTAL	6MIN 59.01 SEC		6MIN 28.42 SEC	

APPENDIX H

COST FLOW MODEL FOR NORDCO MANAGEMENT INFORMATION

Levels